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Distribution of human papillomavirus types, cervical cancer screening history, and risk factors for infection in Manitoba

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This article has been peer reviewed.

Abstract

Objectives: We conducted a study to investigate the prevalence of human papillomavirus (HPV) infections in an opportunistic sample of women in Manitoba, Canada. We inquired about risk factors associated with HPV infections and linked the HPV typing results with the cervical cancer screening history of the participants.

Methods: The study population included 592 women attending Papanicolaou (Pap) test clinics. After signing a consent form, participants were given a self-administered questionnaire on risk factors and received a conventional Pap test. Residual cells from the Pap tests were collected and sent for HPV typing.

Results: The mean age of the population was 43 years. A total of 115 participants (19.4%) had an HPV infection, 89 of whom had a normal Pap test. Of those who were HPV-positive, 61 (10.3%) had high-risk (Group 1) HPV. HPV-16 was the most prevalent type (15/115: 13.0% of infections). The most consistent risk factors for HPV infection were young age, Aboriginal ethnicity, higher lifetime number of sexual partners and higher number of sexual partners in the previous year.

Conclusion: The prevalence of HPV types in Manitoba is consistent with the distributions reported in other jurisdictions. These data provide baseline information on type-specific HPV prevalence in an unvaccinated population and can be useful in evaluating the effectiveness of the HPV immunization program. An added benefit is in the validation of a proof of concept which links a population-based Pap registry to laboratory test results and a risk behaviour survey to assess early and late outcomes of HPV infection. This methodology could be applied to other jurisdictions across Canada where such capacities exist.

Keywords: *papillomavirus infections, prevalence, risk factors, uterine cervical dysplasia, early detection of cancer*

Introduction

The publicly funded human papillomavirus (HPV) immunization programs implemented across Canada between 2007 and 2009 have the potential to prevent a large proportion of anogenital warts, high-grade cervical lesions and HPV-related invasive cancers.^{1,6} They also have the potential to influence cervical cancer screening as currently practiced because of the changes in prevalence of cervical abnormalities they can bring about.^{1,2} The extent of this impact, however, will depend on the distribution of HPV types, the type-specific infection rates among females and the vaccine uptake.

The objective of this study was to determine the baseline type-specific prevalence of and risk factor for HPV infection in an opportunistic sample of women attending walk-in, no-appointment Papanicolaou (Pap) test clinics in Manitoba (Canada) during an annual cervical cancer awareness week. The survey information and HPV typing results were linked to the Manitoba Cervical Cancer Screening Program (MCCSP) database. Manitoba is well positioned to host and conduct this kind of surveillance projects because of the availability of linkable population-based databases on cancer,

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cervical screening, medical procedures provided by physicians and immunization.⁸ These resources provide a robust environment to evaluate the impact of the HPV immunization program impact, the utilization of cervical screening among vaccinated and non-vaccinated females, and the resulting disease distribution and outcomes.

Methods

Study environment

Since 2003 the MCCSP has conducted an annual Pap Week in October. During this week women are encouraged to attend Pap test clinics without appointment. The objective is to reach those who have never attended or do not regularly attend cervical screening. In 2008, 123 clinics participated in Pap Week across Manitoba. Of these, 52 consented to take part in this study. In addition to performing conventional Pap tests, these clinics took the residual cells from the Pap tests, put them in a liquid-based cytology medium, and sent the samples to Cadham Provincial Laboratory in Winnipeg, Manitoba, for HPV typing. The participating clinics also supervised the administration of a consent form and a self-administered survey on risk factors for HPV infections.

Population

The study population was composed of an opportunistic sample of women aged 18 years and older from different ethnic backgrounds. Pregnant women were excluded. Women interested in participating in the study discussed the objectives with clinic staff and, upon agreement, signed a consent form and completed a risk factor questionnaire. Women who decided not to complete the questionnaire were still eligible for HPV testing, and their HPV results were included in the analysis.

The study was publicized on posters in the clinics, and staff told potential participants about it. Overall, 1182 women underwent cervical screening in the 52 participating clinics, and 642 (54%) consented to participate in the study.

Follow-up of participants

Health care providers received the Pap test results and the HPV typing results. Medical management of participants diagnosed with cervical abnormalities followed the MCCSP cervical cancer screening management guidelines in effect at the time of the study. Women who tested positive for high-risk HPV and negative for cytology were recalled by the clinics for further investigation according to the MCCSP guidelines.

Risk factor survey

The survey included questions on socio-demographic characteristics and relevant risk factors for cervical neoplasia including smoking, oral contraceptive use, recent sexual activity, previous diagnosis with sexually transmitted infections and HPV immunization status. The questionnaire was tested to a grade four reading level before use.

Cervical specimen processing and HPV detection and typing

The Luminex assay is a method developed at the National Microbiology Laboratory that detects 45 HPV types. These include 23 of the 25 high-risk (as defined by the International Agency for Research on Cancer) types found in groups 1, 2a and 2b: HPV types 16, 18, 26, 30, 31, 33, 35, 39, 45, 51, 52, 53, 56, 58, 59, 66, 67, 68, 69, 70, 73, 82 and 85.⁹ Also included are 22 types considered of low risk or unknown risk: HPV types 6, 11, 13, 32, 40, 42, 43, 44, 54, 61, 62, 71, 72, 74, 81, 83, 84, 86, 87, 89, 90 and 91. In brief, samples in viral transport medium were centrifuged and their DNA extracted from the resulting pellet using a MagnaZorb DNA extraction kit.^{10,11} The DNA was amplified with a nested polymerase chain reaction (PCR) method using the general PGM1 primer set for the first round¹² and the GP5+/GP6+ primer set for the second.¹³ This method amplifies a fragment of the L1 region of the HPV genome (about 150 base pairs in length). The quality of the DNA sample for PCR was checked by co-amplification

of the human beta-globin gene. PCR products were visually detected by gel electrophoresis.^{13,16}

HPV DNA was detected and typed by hybridization to microspheres coupled to specific probes for the 45 HPV types according to the xMAP Luminex technology*. Specificity and sensitivity of this method for all the 45 types of HPV was measured using cloned HPV DNAs. Comparison against the LinearArray (Roche)¹⁷ and other HPV genotyping kits showed that this Luminex assay is comparable to other commercial genotyping methods.¹⁸

Data analysis

HPV typing results and survey results were linked to the MCCSP database using a unique identifier in order to get the results of the Pap tests performed during Pap Week 2008 and the cervical cancer screening history of the consenting participants. Univariate and multivariate logistic regression analyses was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) as estimates of the relative risk of HPV detection associated with the various predictor variables. Because of the higher prevalence of HPV in women aged less than 30 years, results were tabulated for women aged less than 30 years and for those aged 30 years plus. HPV types were grouped according to Bouvard et al. and de Villiers et al.^{9,19}

The protocol was approved by the research ethics boards of Health Canada/ Public Health Agency of Canada and the University of Manitoba.

Results

Tissue samples collected from the 642 women who consented to participate in the study were sent for HPV infection testing. Of these, 33 women did not complete the consent form and were excluded from the analyses. A further 17 were excluded because of inadequate samples. The final study population included 592 participants, of which 527 completed the questionnaire. The

* <http://www.luminexcorp.com/>

mean age of the study population was 43 years (median: 44). The mean age of infected women was 35 years (median: 31 years), and the mean age of non-infected women was 45 years (median: 46 years). The majority of participants came from rural areas (66.3%), and the remainder came from Winnipeg and Brandon.

Survey results

Variables associated with the HPV infection using univariate analysis are reported in Table 1. Results are presented for women aged less than 30 years (referred to as "younger") and for women aged 30 years and older (referred to as "older") to

reflect the higher prevalence of HPV infections in younger women. In older women, HPV infection was associated with Aboriginal ethnicity and a self-described difficult financial situation. Compared with non-smokers, participants who smoked were at greater risk of being HPV-positive, regardless of age. Not having a history of

TABLE 1
Survey results by age and HPV infection status

Variables ^a	Categories	Age < 30 years				Age ≥ 30 years			
		HPV- (n = 75)		HPV+ (n = 56)		HPV- (n = 402)		HPV+ (n = 59)	
		n	%	n	%	n	%	n	%
Ethnic identity	Aboriginal	18	(24.0)	19	(33.9)	1.7	(0.7, 3.8)	58	(14.4)
	Caucasian	38	(50.7)	24	(42.9)	Reference		26	(44.1)
	Other	10	(13.3)	3	(5.4)	0.5	(0.1, 1.9)	5	(8.5)
	Not stated	9	(12.0)	10	(17.9)	1.8	(0.6, 5.0)	42	(10.4)
Financial situation	Difficult	5	(6.7)	5	(8.9)	1.3	(0.3, 4.9)	19	(4.7)
	Moderate	20	(26.7)	14	(25.0)	0.9	(0.4, 2.1)	110	(27.4)
	Comfortable	32	(42.7)	25	(44.6)	Reference		19	(32.2)
	Very comfortable	9	(12.0)	2	(3.6)	0.3	(0.1, 1.4)	5	(8.5)
	Not stated	9	(12.0)	10	(17.9)	1.4	(0.5, 4.0)	40	(10.0)
Education	High school or less	28	(37.3)	19	(33.9)	Reference		139	(34.6)
	College	14	(18.7)	8	(14.3)	0.8	(0.3, 2.4)	114	(28.4)
	University	25	(33.3)	19	(33.9)	1.1	(0.5, 2.6)	110	(27.4)
	Not stated	8	(10.7)	10	(17.9)	1.8	(0.6, 5.5)	39	(9.7)
Currently smoking	Yes	21	(28.0)	23	(41.1)	2.5	(1.1, 5.7)	101	(25.1)
	Former smoker	7	(9.3)	6	(10.7)	2.0	(0.6, 6.7)	103	(25.6)
	Never	39	(52.0)	17	(30.4)	Reference		15	(25.4)
	Not stated	8	(10.7)	10	(17.9)	2.9	(1.0, 8.5)	39	(9.7)
Currently use oral contraceptive	Yes	24	(32.0)	15	(26.8)	0.7	(0.3, 1.6)	18	(4.5)
	No	31	(41.3)	27	(48.2)	Reference		292	(72.6)
	Don't know	2	(2.7)	1	(1.8)	—		1	(0.2)
	Not stated	18	(24.0)	13	(23.2)	0.8	(0.3, 2.0)	91	(22.6)
Ever had a Pap test	Yes	47	(62.7)	41	(73.2)	Reference		357	(88.8)
	No	20	(26.7)	5	(8.9)	0.3	(0.1, 0.8)	7	(1.7)
	Don't know	0	(0.0)	0	(0.0)	—		0	(0.0)
	Not stated	8	(10.7)	10	(17.9)	1.4	(0.5, 4.0)	38	(9.5)
Ever had an STI	Yes	15	(20.0)	18	(32.1)	Reference		55	(13.7)
	No	52	(69.3)	24	(42.9)	0.4	(0.2, 0.9)	286	(71.1)
	Don't know	0	(0.0)	4	(7.1)	—		20	(5.0)
	Not stated	8	(10.7)	10	(17.9)	1.0	(0.3, 3.3)	41	(10.2)
Number of children	None	44	(58.7)	29	(51.8)	Reference		48	(11.9)
	1	10	(13.3)	9	(16.1)	1.4	(0.5, 3.8)	33	(8.2)
	2	7	(9.3)	5	(8.9)	1.1	(0.3, 3.7)	113	(28.1)
	≥ 3	4	(5.3)	2	(3.6)	0.8	(0.1, 4.4)	167	(41.5)
	Not stated	10	(13.3)	11	(19.6)	1.7	(0.6, 4.4)	41	(10.2)
Number of sexual partners over last year	0	7	(9.3)	2	(3.6)	0.7	(0.1, 3.8)	74	(18.4)
	> 0 ^b	0	(0.0)	1	(1.8)	—		7	(1.7)
	1	48	(64.0)	19	(33.9)	Reference		280	(69.7)
	2 or more	15	(20.0)	26	(46.4)	4.4	(1.9, 10.0)	12	(3.0)
	Not stated	5	(6.7)	8	(14.3)	4.0	(1.2, 13.9)	29	(7.2)

Continued on the following page

TABLE 1 (continued)
Survey results by age and HPV infection status

Variables ^a	Categories	Age < 30 years			Age ≥ 30 years		
		HPV- (n = 75)		OR (95% CI)	HPV- (n = 402)		OR (95% CI)
		n	%		n	%	
Lifetime number of sexual partners	0	6 (8.0)	2 (3.6)	1.0 (0.2, 5.6)	12 (3.0)	3 (5.1)	3.3 (0.9, 13.0)
	> 0 ^b	5 (6.7)	1 (1.8)	—	23 (5.7)	4 (6.8)	—
	1–4	36 (48.0)	12 (21.4)	Reference	227 (56.5)	17 (28.8)	Reference
	≥ 5	24 (32.0)	33 (58.9)	4.1 (1.8, 9.5)	111 (27.6)	28 (47.5)	3.4 (1.8, 6.4)
	Not stated	4 (5.3)	8 (14.3)	6.0 (1.5, 23.5)	29 (7.2)	7 (11.9)	3.2 (1.2, 8.4)
Had unprotected anal sex over last year	Yes	14 (18.7)	10 (17.9)	0.9 (0.4, 2.4)	38 (9.5)	7 (11.9)	0.8 (0.3, 1.8)
	No	52 (69.3)	35 (62.5)	Reference	307 (76.4)	43 (72.9)	Reference
	Don't know	0 (0.0)	1 (1.8)	—	3 (0.7)	0 (0.0)	—
	Not stated	9 (12.0)	10 (17.9)	1.6 (0.5, 5.2)	54 (13.4)	9 (15.3)	0.9 (0.3, 2.6)
Currently in a stable relationship	Yes	54 (72.0)	23 (41.1)	Reference	289 (71.9)	35 (59.3)	Reference
	No	11 (14.7)	19 (33.9)	4.1 (1.7, 9.9)	64 (15.9)	12 (20.3)	1.5 (0.8, 3.1)
	Not sure	1 (1.3)	4 (7.1)	—	4 (1.0)	3 (5.1)	—
	Not stated	9 (12.0)	10 (17.9)	2.6 (0.9, 7.3)	45 (11.2)	9 (15.3)	1.7 (0.7, 3.7)
Total number of Pap tests ^c	0	22 (29.3)	14 (25.0)	0.8 (0.3, 1.8)	43 (10.7)	11 (18.6)	2.1 (1.0, 4.5)
	1–4	30 (40.0)	25 (44.6)	Reference	270 (67.2)	33 (55.9)	Reference
	5+	23 (30.7)	17 (30.4)	0.9 (0.4, 2.0)	89 (22.1)	15 (25.4)	1.4 (0.7, 2.7)
Total number of colposcopies ^c	0	64 (85.3)	49 (87.5)	Reference	379 (94.3)	55 (93.2)	Reference
	1+	11 (14.7)	7 (12.5)	0.8 (0.3, 2.3)	23 (5.7)	4 (6.8)	1.2 (0.4, 3.6)
Worst cytology ^c	No history	22 (29.3)	14 (25.0)	1.0 (0.5, 2.4)	43 (10.7)	11 (18.6)	2.0 (1.0, 4.3)
	Normal	42 (56.0)	26 (46.4)	Reference	323 (80.3)	40 (67.8)	Reference
	Other than normal	11 (14.7)	16 (28.6)	2.4 (0.9, 5.8)	36 (9.0)	8 (13.6)	1.8 (0.8, 4.1)
Worst histology ^c	No history	64 (85.3)	49 (87.5)	Reference	379 (94.3)	55 (93.2)	Reference
	Normal	3 (4.0)	2 (3.6)	0.9 (0.1, 5.4)	12 (3.0)	1 (1.7)	0.6 (0.1, 4.5)
	Other than normal	8 (10.7)	5 (8.9)	0.8 (0.3, 2.7)	11 (2.7)	3 (5.1)	1.9 (0.5, 6.9)

Abbreviations: ASC-H, atypical squamous cells—cannot rule out high-grade lesion; ASC-US, atypical squamous cells of unknown significance; CI, confidence interval; CIN, cervical intraepithelial neoplasia; HPV, human papillomavirus; HPV-, HPV-negative; HPV+, HPV-positive; HSIL, high-grade squamous intraepithelial lesions; LSIL, low-grade squamous intraepithelial lesions; OR, odds ratio; Pap, Papanicolaou; STI, sexually transmitted infection.

Note: Bolded values are significant.

^a Variables are all self-reported.

^b Value obtained by combining information on the number of children and sexual activity questions.

^c Manitoba Cervical Cancer Screening Program data; other cytology: ASC-US, LSIL, ASC-H, HSIL; other histology: CIN I, CIN II, CIN III; all the other variables are self-reported by the participants.

sexually transmitted infections (STIs) was protective for HPV infection for both age groups. Women with a higher number of lifetime sexual partners or a higher number of sexual partners over the previous year were more likely to be HPV-positive. Younger women who were not in a stable relationship were more likely to be HPV-positive than those in a stable relationship or older women.

In the multivariate logistic regression analysis, being younger (OR = 0.97; 95% CI: 0.95–0.99; age was treated as a continuous variable), Aboriginal (OR = 4.83; 95% CI: 2.70–8.65; compared to non-Aboriginal), and having two or more sexual partners in the previous year

(OR = 2.04; 95% CI: 1.20–3.47 compared to one or no sexual partner) were significant predictors for testing HPV-positive. The variables that were not significant predictors of HPV infection in the multivariate model were currently smoking (yes/no), Pap test history (yes/no), history of cervical abnormality (yes/no) and having had at least two consecutive screening events within a year (yes/no).

Reported and registry-based Pap test history

Older women who had had zero Pap tests between 2001 (the year the MCCSP database was started) and October 2008 were at higher risk of being HPV-positive (Table 1; data from the MCCSP). A similar

trend was observed with Pap test history, although the number of respondents who had had no Pap test was small. Younger women who self-reported not ever having a Pap test were at lower risk of having an HPV infection, although this was not observed when the analyses were performed with the MCCSP data.

HPV infections and cytological outcomes

A total of 115 participants (19%) were found to be HPV-positive (Table 2). Overall, 33% (38/115) of these infections were among participants aged less than 25 years. The participants aged less than 25 years were also more likely to be infected with Group 1 HPV types

TABLE 2
Age distribution of women by infection status and HPV type (person-based)

Age, years	HPV ^a n (%)	HPV ⁺⁺ n (%)	Group 1 ^b n (%)	HPV 16 or 18 ^c n (%)	Group 2 ^d n (%)	HPV 6 or 11 ^e n (%)	Low-risk ^f n (%)	Multiple infections	Total n (%)
< 25	40 (8.4)	38 (33.0)	27 (44.3)	8 (40.0)	4 (21.1)	3 (75.0)	13 (29.5)	15 (50.0)	78 (13.2)
25-29	35 (7.3)	18 (15.7)	9 (14.8)	4 (20.0)	3 (15.8)	1 (25.0)	7 (15.9)	4 (13.3)	53 (9.0)
30-34	46 (9.6)	5 (4.3)	5 (8.2)	2 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.3)	51 (8.6)
35-39	41 (8.6)	9 (7.8)	2 (3.3)	0 (0.0)	3 (15.8)	0 (0.0)	4 (9.1)	1 (3.3)	50 (8.4)
40-44	66 (13.8)	11 (9.6)	6 (9.8)	1 (5.0)	1 (5.3)	0 (0.0)	5 (11.4)	2 (6.7)	77 (13.0)
45-49	56 (11.7)	14 (12.2)	4 (6.6)	1 (5.0)	3 (15.8)	0 (0.0)	7 (15.9)	3 (10.0)	70 (11.8)
50-54	62 (13.0)	10 (8.7)	5 (8.2)	2 (10.0)	2 (10.5)	0 (0.0)	4 (9.1)	3 (10.0)	72 (12.2)
55-59	51 (10.7)	5 (4.3)	2 (3.3)	2 (10.0)	1 (5.3)	0 (0.0)	2 (4.5)	0 (0.0)	56 (9.5)
60-64	36 (7.5)	4 (3.5)	1 (1.6)	0 (0.0)	2 (10.5)	0 (0.0)	1 (2.3)	1 (3.3)	40 (6.8)
65+	44 (9.2)	1 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.3)	0 (0.0)	45 (7.6)
Total	477	115	61	20	19	4	44	30	592

Abbreviation: HPV, human papillomavirus.

^a Any HPV type included in Group 1, Group 2, and low risk (see text); note that HPV 34 and 97, which belong to Group 2,^g are not included in the HPV types covered by the methodology used in this study.

^b Group 1: HPV 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59.

^c Either one type or both present at the same time.

^d Group 2: HPV 26, 30, 53, 66, 67, 68, 69, 70, 73, 82, 85.

^e Low-risk: HPV 6, 11, 13, 32, 40, 42, 43, 44, 54, 61, 62, 71, 72, 74, 81, 83, 84, 86, 87, 89, 90, 91.

(44%; 27/61) than Group 2 types (21%; 4/19). While HPV types 6 and 11 were not detected in women aged 30 years plus, HPV types 16 and 18 (but mostly 16) were detected over a wider age range. One-quarter of the infected women (26%; 30/115) had multiple HPV infections, that is, more than one HPV of any type.

Of the study population with a normal Pap test, 17% (89/517) tested positive for an HPV infection and 9% (46/517) were infected with Group 1 HPV (Table 3). Overall, 7% (41/592) of all participants had an abnormal Pap test result. An HPV infection (any type) was found in 11% of unsatisfactory Pap tests (2/18), 32% of atypical squamous cells of unknown significance (ASC-US; 6/19), 63% of low-grade squamous intraepithelial lesions (LSIL; 10/16) and 75% of high-grade squamous intraepithelial lesions (HSIL; 3/4). Group 1 HPV type was found in 6% of unsatisfactory Pap tests (1/18), 11% of ASC-US (2/19), 38% of LSIL (6/16) and 75% of HSIL (3/4). Group 1 HPV types (overall: 10.3% [61/592]; among HPV-infected participants: 53.0% [61/115]) were detected more frequently than Group 2 (overall: 3.2% [19/592]; among HPV-infected participants: 16.5% [19/115])

and low-risk HPV types (overall: 7.4% [44/592]; among HPV infected participants: 38.2% [44/115]). Pap test results were not available for 3% (16/592) of the HPV samples tested.

It is not clear why some Pap tests were not sent to the lab for evaluation. We suspect that the clinicians that performed these tests understood that taking a tissue sample for HPV typing

TABLE 3
Person-based HPV prevalence by cytological outcome

HPV types	Missing n	Normal n	Unsatisfactory n	ASC-US n	LSIL n	ASC-H n	HSIL n	Total n	%
Negative	11	428	16	13	6	2	1	477	80.6
Any ^a	5	89	2	6	10	0	3	115	19.4
6 or 11 ^b	0	3	1	0	0	0	0	4	0.7
16	2	10	0	1	2	0	0	15	2.5
16 or 18 ^c	2	14	0	1	2	0	1	20	3.4
Group 1 ^d	3	46	1	2	6	0	3	61	10.3
Group 2 ^e	1	13	0	2	2	0	1	19	3.2
Low-risk ^f	1	36	1	3	3	0	0	44	7.4
Multiple ^g	1	22	0	2	4	0	1	30	5.1
Total	16	517	18	19	16	2	4	592	

Abbreviations: ASC-H, atypical squamous cells—cannot rule out high-grade lesion;

ASC-US, atypical squamous cells of unknown significance; HPV, human papillomavirus;

HSIL, high-grade squamous intraepithelial lesions; LSIL, low-grade squamous intraepithelial lesions.

^a Any HPV type included in Group 1, Group 2, and low risk (see following text); note that HPV 34 and 97, which belong to Group 2,^g are not included in the HPV types covered by the methodology that was used in this study.

^b One type or the other or both can be present at the same time.

^c Group 1: HPV 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59.

^d Group 2: HPV 26, 30, 53, 66, 67, 68, 69, 70, 73, 82, 85.

^e Low-risk: HPV 6, 11, 13, 32, 40, 42, 43, 44, 54, 61, 62, 71, 72, 74, 81, 83, 84, 86, 87, 89, 90, 91.

^f Multiple HPV infections.

was their only task for this study and did not request a regular cytological testing.

Among Group 1 types, HPV-16 (10%) was the most frequently detected followed by HPV-39 (5%), 58 (5%), 18 (4%), 35 (4%), 51 (4%), 52 (4%), 59 (4%) and 33 (3%) (Table 4). Within the genus alpha, species 9 (29%; 45/157), 3 (19%; 29/157) and 7 (17%; 26/157) were the most frequently detected. Species 9 includes viruses related to HPV-16, while species 7 includes those related to HPV-18, and species 3 includes low-risk HPV types.

Discussion

Comparing the prevalence of HPV infections across studies is difficult because typing technologies, sampled populations and sampling strategies are often different. In addition, prevalence rates are rarely age-standardized. With this in mind, a meta-analysis reported HPV infection rates as varying from 7% to 8% in Europe and Asia, 14% in North America, and 23% in Africa in women with normal cytology.³⁰ In the United States, rates have been estimated as 27% in females aged 14 to 59 years.²¹ Our study found an HPV prevalence of 19% (17% among those with a normal Pap test). HPV-16 was the most prevalent cervical type detected, while other common high-risk types included types 18, 33, 35, 39, 51, 52, 58 and 59. These results are consistent with other findings where HPV types 16, 18, 31, 39, 51, 52, 56 and 58 were found to be among the most frequent types worldwide in women with normal cytological findings;²² HPV types 16, 18, 31, 33, 45, 51, 52, 56 and 58 in women diagnosed with low-grade cervical lesions;²³ and HPV types 16, 18, 31, 33, 35, 45, 52 and 58 in women diagnosed with high-grade abnormalities.²⁴ HPV type-specific prevalence rankings, however, varied regionally and by country.^{22,24} For example, a Belgium population-based study reported that the most common high-risk type was HPV-16 (3.7%), followed by types 31, 51 and 53, which were identified in at least 2% of the population (HPV-18 was found in 1.5% of the population).²⁵ A Swedish population-based study reported infection prevalence for HPV-16 of 2.5%, followed by HPV-31 (1.4%), HPV-45 (0.9%)

TABLE 4
Infection-based prevalence of the HPV genital species of the alpha genus

	HPV types	Missing n	Negative n	Unsatisfactory n	ASC-US n	LSIL n	HSIL n	Total n %	
A1	32	0	4	0	0	0	0	4	2.5
	42	0	6	0	0	0	0	6	3.8
	Total	0	10	0	0	0	0	10	6.4
A3	62	0	5	0	1	0	0	6	3.8
	72	0	2	0	0	0	0	2	1.3
	81	0	5	0	0	1	0	6	3.8
	83	0	3	0	0	1	0	4	2.5
	84	0	2	0	0	0	0	2	1.3
	86	0	2	0	0	0	0	2	1.3
	89	0	6	0	0	1	0	7	4.5
	Total	0	25	0	1	3	0	29	18.5
A5	51	0	4	0	0	1	1	6	3.8
	69	0	1	0	0	0	0	1	0.6
	82	0	1	0	0	0	0	1	0.6
	Total	0	6	0	0	1	1	8	5.1
A6	30	0	2	0	0	1	0	3	1.9
	53	0	0	0	0	1	1	2	1.3
	56	0	3	0	0	0	0	3	1.9
	66	0	4	0	0	0	0	4	2.5
	Total	0	9	0	0	2	1	12	7.6
A7	18	0	5	0	0	0	1	6	3.8
	39	1	4	0	0	1	1	7	4.5
	45	0	1	0	0	0	0	1	0.6
	59	0	5	0	0	1	0	6	3.8
	70	0	4	0	1	0	0	5	3.2
	85	0	1	0	0	0	0	1	0.6
	Total	1	20	0	1	2	2	26	16.6
A8	7	0	1	0	0	0	0	1	0.6
	40	0	1	0	2	0	0	3	1.9
	91	0	0	0	1	0	0	1	0.6
	Total	0	2	0	3	0	0	5	3.2
A9	16	2	10	0	1	2	0	15	9.6
	31	0	2	0	1	0	0	3	1.9
	33	0	5	0	0	0	0	5	3.2
	35	0	4	0	0	1	1	6	3.8
	52	0	6	0	0	0	0	6	3.8
	58	1	4	1	0	1	0	7	4.5
	67	1	1	0	0	1	0	3	1.9
	Total	4	32	1	2	5	1	45	28.7
A10	6	0	2	0	0	0	0	2	1.3
	11	0	1	1	0	0	0	2	1.3
	44	1	3	0	1	0	0	5	3.2
	74	0	5	0	0	0	0	5	3.2
	Total	1	11	1	1	0	0	14	8.9
A11	73	0	0	0	1	0	0	1	0.6
A13	54	0	4	0	0	1	0	5	3.2
Other	8	0	1	0	0	0	0	1	0.6
	30	0	0	0	0	1	0	1	0.6
	Total	0	1	0	0	1	0	2	1.3
Total		6	120	2	9	15	5	157	

Abbreviations: ASC-H, atypical squamous cells—cannot rule out high-grade lesion;

ASC-US, atypical squamous cells of unknown significance; HPV, human papillomavirus;

HSIL, high-grade squamous intraepithelial lesions; LSIL, low-grade squamous intraepithelial lesions.

and HPV-18 (0.7%); 13.0% of women had multiple infections.²⁶ Many studies have reported an increase in HPV infections in women 60 years of age and older.²⁷ There were insufficient cases to confirm that trend in Manitoba.

A few studies have investigated the prevalence of HPV in Canada. A British Columbia study found an overall HPV prevalence rate of 16.8% (high-risk HPV: 13.9%; HPV-16: 10.7%);²⁸ an Ontario study found an overall infection rate of 13.3% (high-risk HPV: 9.6%, HPV-16: 7.3%);²⁹ A New Brunswick study found a prevalence of 28% (high-risk HPV: 21%).³⁰ A study conducted between 1992 and 1995 recruited a large proportion of Aboriginal women (42%) from a clinic located in a low-income inner-city area of Winnipeg, Manitoba, and found that HPV infections rates in Aboriginal and non-Aboriginal women were comparable (33.6% and 31.8%, respectively).³¹ However, because of the different populations included in our present study and this earlier one, comparison of results is difficult.

The prevalence of high-risk HPV has been consistently reported to increase with the severity of lesions. For example, a meta-analysis reported high-risk HPV in 71.9% (95% CI: 62.8%–80.9%) of LSIL cases²³ and 88.3% (95% CI: 85.8%–90.8%) of HSIL cases.²⁴ Moore et al.²⁸ reported that 52.3% of LSIL and 79.4% of HSIL contained high-risk HPV. They also found that HPV positivity increased from normal (12.3%) to benign (19.6%) to low-grade (69.3%) to high-grade (81.0%).²⁸ We found 37.5% of LSIL were high-risk (Group 1) HPV-positive, as were 75% of HSIL.

A number of cofactors are associated with risk of having an HPV infection and different grades of cervical abnormalities, many of which are related to sexual behaviours. The factors that have been the most consistently associated with higher rates of HPV infections include younger age and having a greater number of lifetime and recent sex partners.^{32,33} Other cofactors for HPV infection, including age at sexual debut, smoking, oral contraceptive use, ethnicity, alcohol consumption, history of STI, income, and

condom use have also been reported, but not consistently.^{33,41} The multivariate analysis showed that age, ethnicity, and the number of sexual partners in the last year were independent predictors. Our present study also suggests that some of these risk factors are common for all age groups while other factors are found only in either younger or older women.

Women with no history of cervical cancer screening and those who were under-screened have been reported to have higher incidence rates of cervical cancer than women who regularly received screening.^{42–45} In the present study, women 30 years of age and older with no Pap test history were found to be HPV-positive more often.

Limitations of the study

The present study has several limitations. As with almost all seroprevalence studies, our study relied on opportunistic samples and was not population-based. Consequently, the results do not necessarily represent the rate of HPV infections in the general female population. The publicity made around Pap Week in Manitoba and the clinics dedicated to one-day screening could also create a selection bias by encouraging symptomatic women who have delayed screening to finally get a Pap test. It is difficult to predict the outcome of such bias on the current risk factor analysis, but if it is differential, it may explain why the risk of infection was higher in some groups of people. The cervical screening participation rate in Manitoba between 2007 and 2009 in women aged 20 to 69 years was 65.9%. The breakdown of their cytological results was normal cytology, 95.5%; ASC-US 3.1%; LSIL 2.1%; atypical glandular cells (AGC) 0.1%; ASC-H 0.3%; and HSIL 0.9%. Among study participants, the cervical screening participation rate since 2001 was 84.8% (502/592), with a breakdown of cytology results of normal cytology 87% (517/592); ASC-US 3% (19/592); LSIL 3% (16/592); ASC-H 0.3% (2/592); and HSIL 1% (4/592).

This comparison suggests that most of the study participants attend cervical screening regularly and that their cytological

outcomes were comparable to the women who attended cervical screening in Manitoba between 2007 and 2009. The cross-sectional nature of the study design does not allow for establishing a causal relationship between HPV infection and the cofactors investigated. In addition, self-administered questionnaires can be subject to biases. Nevertheless, findings are consistent with current knowledge on risk factors for HPV infections. Due to the high sensitivity of the HPV detection method, the clinical significance of the present study is limited. The PCR amplification can detect as little as one copy of the targeted genes (L1 DNA), and this sensitivity does not necessarily translate into infection of clinical significance. Depuydt et al. showed that below a critical viral load, detection of visually detectable lesions is very rare.⁴⁶ A highly sensitive test has the potential to limit the triaging of people with HPV infections.

Conclusion

The results from our study suggest that the distribution of oncogenic HPV types in Manitoba is in accordance with what has been reported in Canada and in other countries. These data provide a baseline of HPV prevalence in an unvaccinated population in Manitoba. In addition, the use of data linkage provides a proof of concept for the applicability of population-based registry linkage to evaluate HPV immunization programs in those jurisdictions where the capacity to conduct such linkages exist.

References

1. Garnett GP, Kim JJ, French K, Goldie SJ. Chapter 21: Modelling the impact of HPV vaccines on cervical cancer and screening programmes. *Vaccine*. 2006;24 Suppl 3:S178–86.
2. Brisson M, Van de Velde N, Boily MC. Different population level vaccination effectiveness for HPV types 16, 18, 6 and 11. *Sex Transm Infect*. 2011;87(1):41–3.
3. Smith MA, Canfell K, Brotherton JML, Lew JB, Barnabas RV. The predicted impact of vaccination on human papillomavirus infections in Australia. *Int J Cancer*. 2008;123(8):1854–63.

4. Donovan B, Franklin N, Guy R, Grulich AE, Regan DG, Ali H, et al. Quadrivalent human papillomavirus vaccination and trends in genital warts in Australia: analysis of national sentinel surveillance data. *Lancet Infect Dis*. 2011;11(1):39-44.
5. Fairley CK, Hocking JS, Gurrin LC, Chen MY, Donovan B, Bradshaw CS. Rapid decline in presentations of genital warts after the implementation of a national quadrivalent human papillomavirus vaccination programme for young women. *Sex Transm Infect*. 2009;85(7):499-502.
6. Munoz N, Kjaer SK, Sigurdsson K, Iversen OE, Hernandez Avila M, Wheeler CM, et al. Impact of human papillomavirus (HPV) 6/11/16/18 vaccine on all HPV-associated genital diseases in young women. *J Natl Cancer Inst*. 2010;102(5):325-39.
7. Tota J, Mahmud SM, Ferenczy A, Coutlée F, Franco EL. Promising strategies for cervical cancer screening in the post human papillomavirus vaccination era. *Sex Health*. 2010;7(3):376-82.
8. Kliever EV, Demers AA, Brisson M, Severini A, Lotocki R, Elias B, et al. The Manitoba human papillomavirus vaccine surveillance and evaluation system. *Health Rep*. 2010;21(2):37-42.
9. Bouvard V, Baan R, Straif K, Grosse Y, Secretan B, El Ghissassi F, et al. A review of human carcinogens—Part B: biological agents. *Lancet Oncol*. 2009;10(4):321-2.
10. Higuchi R. Simple and rapid preparation of samples for PCR. In: Erlich HA, editor. *PCR Technology. Principles and Applications for DNA Amplification*. New York: Stockton Press; 1989. p. 31-8.
11. Josefsson A, Magnusson P, Gyllenstein U. Human papillomavirus detection by PCR and typing by Dot Blot. In: Peeling RW, Sparling PF, editors. *Sexually Transmitted Diseases. Methods and Protocols*. Totowa (NJ): Humana Press; 1999. p. 171-93.
12. Gravitt PE, Peyton CL, Alessi TQ, Wheeler CM, Coutlée F, Hildesheim A, et al. Improved amplification of genital human papillomaviruses. *J Clin Microbiol*. 2000;38(1):357-61.
13. de Roda Husman AM, Walboomers JM, van den Brule AJ, Meijer CJ, Snijders PJ. The use of general primers GP5 and GP6 elongated at their 3' ends with adjacent highly conserved sequences improves human papillomavirus detection by PCR. *J Gen Virol*. 1995 Apr;76 (Pt 4):1057-62.
14. Evander M, Edlund K, Bodén E, Gustafsson A, Jonsson M, Karlsson R, et al. Comparison of a one step and a two step polymerase chain reaction with degenerate general primers in a population based study of human papillomavirus infection in young Swedish women. *J Clin Microbiol*. 1992;30(4):987-92.
15. Strauss S, Jorens JZ, Desselberger U, Gray JJ. Single tube real time nested polymerase chain reaction for detecting human papillomavirus DNA. *Diagn Mol Pathol*. 2000;9(3):151-7.
16. Bulkman NW, Berkhof J, Rozendaal L, van Kemenade FJ, Boeke AJ, Bulk S, et al. Human papillomavirus DNA testing for the detection of cervical intraepithelial neoplasia grade 3 and cancer: 5 year follow up of a randomised controlled implementation trial. *Lancet*. 2007;370(9601):1764-72.
17. Zubach V, Smart G, Ratnam S, Severini A. Novel microsphere based method for detection and typing of 46 mucosal human papillomavirus types. *J Clin Microbiol*. 2012;50(2):460-4.
18. Rebbagtagada A, Perusini A, Di Prima A, Salit I, Galeski V, Severini A. Evaluation of test performance characteristics and operational parameters of 5 HPV genotyping assays. 26th International Papillomavirus Conference, Montreal, Canada, July 3-8: 2010.
19. de Villiers EM, Fauquet C, Broker TR, Bernard HU, Zur Hausen H. Classification of papillomaviruses. *Virology*. 2004;324(1):17-27.
20. de Sanjosé S, Díaz M, Castellsagué X, Clifford G, Bruni L, Munoz N, et al. Worldwide prevalence and genotype distribution of cervical human papilloma virus DNA in women with normal cytology: a meta analysis. *Lancet Infect Dis*. 2007;7(7):453-9.
21. Dunne EF, Unger ER, Sternberg M, McQuillan G, Swan DC, Patel SS, et al. Prevalence of HPV infection among females in the United States. *JAMA*. 2007;297(8):813-9.
22. Bruni L, Díaz M, Castellsagué X, Ferrer E, Bosch FX, de Sanjosé S. Cervical human papillomavirus prevalence in 5 continents: meta analysis of 1 million women with normal cytological findings. *J Infect Dis*. 2010;202(12):1789-99.
23. Clifford GM, Rana RK, Franceschi S, Smith JS, Gough G, Pimenta JM. Human papillomavirus genotype distribution in low grade cervical lesions: comparison by geographic region and with cervical cancer. *Cancer Epidemiol Biomarkers Prev*. 2006;14(5):1157-64.
24. Smith JS, Lindsay L, Hoots B, Keys J, Franceschi S, Winer R, et al. Human papillomavirus type distribution in invasive cervical cancer and high grade cervical lesions: a meta analysis update. *Int J Cancer*. 2007;121(3):621-32.
25. Arbyn M, Sasieni P, Meijer CJ, Clavel C, Koliopoulos G, Dillner J. Chapter 9: clinical applications of HPV testing: a summary of meta analyses. *Vaccine*. 2006;24 (Suppl 3):S3/78-89.
26. Naucler P, Ryd W, Tornberg S, Strand A, Wadell G, Hansson BG, et al. HPV type specific risks of high grade CIN during 4 years of follow up: a population based prospective study. *Br J Cancer*. 2007;97(1):129-32.
27. Burchell AN, Winer RL, de Sanjosé S, Franco EL. Chapter 6: epidemiology and transmission dynamics of genital HPV infection. *Vaccine*. 2006;24(Supplement 3):S52-S61.
28. Moore RA, Ogilvie G, Fornika D, Moravan V, Brisson M, Amirabbasi Beik M, et al. Prevalence and type distribution of human papillomavirus in 5,000 British Columbia women—implications for vaccination. *Cancer Causes Control*. 2009;20(8):1387-96.
29. Sellors JW, Mahony JB, Kaczorowski J, Lytwyn A, Bangura H, Chong S, et al. Prevalence and predictors of human papillomavirus infection in women in Ontario, Canada. Survey of HPV in Ontario Women (SHOW) Group. *CMAJ*. 2000;163(5):503-8.

30. Kurz J, Mitra K, Adam R, Miao X, MacKay JS, Isa NN, et al. PCR detection and typing of genital papillomavirus in a New Brunswick population. *Int J Cancer*. 1993;55(4):604-8.
31. Young TK, McNicol P, Beauvais J. Factors associated with human papillomavirus infection detected by polymerase chain reaction among urban Canadian aboriginal and non-aboriginal women. *Sex Transm Dis*. 1997;24(5):293-8.
32. Trottier H, Franco EL. The epidemiology of genital human papillomavirus infection. *Vaccine*. 2006;24(Suppl 1):S1-15.
33. Scheurer ME, Tortolero-Luna G, Adler-Storthz K. Human papillomavirus infection: biology, epidemiology, and prevention. *Int J Gynecol Cancer*. 2005;15(5):727-46.
34. Moscicki AB, Schiffman M, Kjaer S, Villa LL. Chapter 5: updating the natural history of HPV and anogenital cancer. *Vaccine*. 2006;24(Supplement 3):S42-S51.
35. Trottier H, Burchell AN. Epidemiology of mucosal human papillomavirus infection and associated diseases. *Public Health Genomics*. 2009;12(5-6):291-307.
36. Winer RL, Lee SK, Hughes JP, Adam DE, Kiviat NB, Koutsky LA. Genital human papillomavirus infection: incidence and risk factors in a cohort of female university students. *Am J Epidemiol*. 2003;157(3):218-26.
37. Ho GYF, Bierman R, Beardsley L, Chang CJ, Burk RD. Natural history of cervicovaginal papillomavirus infection in young women. *N Engl J Med*. 1998;338(7):423-8.
38. Moscicki AB, Hills N, Shiboski S, Powell K, Jay N, Hanson E, et al. Risks for incident human papillomavirus infection and low grade squamous intraepithelial lesion development in young females. *JAMA*. 2001;285(23):2995-3002.
39. Goodman MT, Shvetsov YB, McDuffie K, Wilkens LR, Zhu X, Thompson PJ, et al. Prevalence, acquisition, and clearance of cervical human papillomavirus infection among women with normal cytology: Hawaii Human Papillomavirus Cohort Study. *Cancer Res*. 2008;68(21):8813-24.
40. Giuliano AR, Harris R, Sedjo RL, Baldwin S, Roe D, Papenfuss MR, et al. Incidence, prevalence, and clearance of type specific human papillomavirus infections: The Young Women's Health Study. *J Infect Dis*. 2002;186(4):462-9.
41. Sellors JW, Karwalajtys TL, Kaczorowski J, Mahony JB, Lytwyn A, Chong S, et al. Incidence, clearance and predictors of human papillomavirus infection in women. *CMAJ*. 2003;168(4):421-5.
42. Decker K, Demers A, Chateau D, Musto G, Nugent Z, Lotocki R, et al. Papanicolaou test utilization and frequency of screening opportunities among women diagnosed with cervical cancer. *Open Med*. 2009;3(3):140-7.
43. Boulanger JC, Fauvet R, Urrutiauer S, Drea Y, Sevestre H, Garry O, et al. [Cytological history of cases of invasive cervical cancer diagnosed in France in 2006.] *Gynecol Obstet Fertil*. 2007;35(9):764-71.
44. van der Aa MA, Schutter EM, Looijen-Salamon M, Martens JE, Siesling S. Differences in screening history, tumour characteristics and survival between women with screen detected versus not screen detected cervical cancer in the east of The Netherlands, 1992-2001. *Eur J Obstet Gynecol Reprod Biol*. 2008;139(2):204-9.
45. Priest P, Sadler L, Peters J, Crengle S, Bethwaite P, Medley G, et al. Pathways to diagnosis of cervical cancer: screening history, delay in follow up, and smear reading. *BJOG*. 2007;114(4):398-407.
46. Depuydt CE, Arbyn M, Benoy III, Vandepitte J, Verceken AJ, Bogers JJ. Quality control for normal liquid based cytology: rescreening, high risk HPV targeted reviewing and/or high risk HPV detection? *J Cell Mol Med*. 2009;13(9B):4051-60.

Features of physician services databases in Canada

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Abstract

Introduction: Physician services databases (PSDs) are a valuable resource for research and surveillance in Canada. However, because the provinces and territories collect and maintain separate databases, data elements are not standardized. This study compared major features of PSDs.

Methods: The primary source was a survey of key informants that collected information about years of data, patient/provider characteristics, database inclusions/exclusions, coding of diagnoses, procedures and service locations. Data from the Canadian Institute for Health Information's (CIHI) National Physician Database were used to examine physician remuneration methods, which may affect PSD completeness. Survey data were obtained for nine provinces and two territories.

Results: Most databases contained post-1990 records. Diagnoses were frequently recorded using ICD-9 codes. Other coding systems differed across jurisdictions and time, although all PSDs identified in-hospital services and distinguished family medicine from other specialties. Capture of non-fee-for-service records varied and CIHI data revealed an increasing proportion of non-fee-for-service physicians over time.

Conclusion: Further research is needed to investigate the potential effects of PSD differences on comparability of findings from pan-Canadian studies.

Keywords: administrative health databases, physician services, medical insurance programs, International Classification of Diseases

Introduction

Administrative health data, which are collected to monitor and manage health systems, are a rich resource for research and surveillance in Canada. The data are obtained from multiple sectors including health insurance registration systems, inpatient facilities, emergency departments, medical services plans, vital statistics files and prescription drug systems. Increasingly, administrative data are being used to conduct pan-Canadian studies on population health and the

use of health services. For example, the Public Health Agency of Canada's Canadian Chronic Disease Surveillance System uses diagnoses recorded in hospital and physician records to estimate prevalence and incidence for such conditions as diabetes and hypertension for all Canadian provinces and territories.^{1,2} Multi-province chronic disease studies using administrative data have also been undertaken for rheumatic diseases, inflammatory bowel disease and mental disorders,^{3,4} and are underway for other conditions, including hypertension.⁵ Administrative health

data are appealing for research and surveillance because they provide an economical alternative to primary data collection, encompass entire populations and span multiple years.

Despite the many advantages of administrative health data, their use is not without challenges. Canada has a system of universal health care, but the delivery of services is a provincial and territorial responsibility. The collection and management of most administrative data are undertaken using information systems developed for each province and territory, which may contribute to a lack of standardization and harmonization in how the data are collected and recorded. Exceptions are the national hospital databases developed by the Canadian Institute for Health Information (CIHI), including the Discharge Abstract Database and the Hospital Morbidity Database, which use a common abstraction form and quality evaluation methodology.

Data quality is a relevant research topic in today's environment, where large databases are frequently used for decision making and policy development.⁶ Researchers, epidemiologists and decision makers interested in undertaking pan-Canadian studies could benefit from results of comparisons of administrative health data from different jurisdictions. Information about features of these data can facilitate developing quality evaluation methodologies and research protocols to investigate the potential impact of differences on study findings. Physician services databases (PSDs), which contain billing records or claims for physician

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contacts with patients, are particularly important for chronic disease research and surveillance. They are a source of diagnosis and procedure information for outpatient visits, and contain information about contacts with both primary care and specialist physicians. Given this background, the purpose of this study was to compare major features of PSDs in Canada's provinces and territories. A paper on this topic is critical to establishing a baseline level of scientific knowledge. Further, this article will likely remain relevant for some time because many database features, including first year of data accessible to researchers, International Classification of Diseases (ICD) version, number of diagnosis fields, specificity of diagnosis fields and availability of information about out-of-province services, are unlikely to change quickly; in fact, they have been static in several provinces and territories over recent years.

Methods

The primary source of data for this study was a survey, emailed to key informants from all provinces and territories, to collect information about selected features of PSDs. Published CIHI reports were a secondary source of data, and were used to collect information about the ways physicians are remunerated, a factor that can affect completeness of PSDs.⁸

Key informants were primarily identified from the membership of the Hypertension Outcomes and Surveillance Team (HOST),⁹ a subgroup of the Canadian Hypertension Education Program Outcomes Research Task Force (CHEP-ORTF). HOST includes approximately 20 researchers, analysts and government representatives from British Columbia, Alberta, Saskatchewan, Manitoba, Ontario and Quebec as well as from the Public Health Agency of Canada and Statistics Canada. Members of HOST have expertise in health services or population health research or surveillance using administrative data. In those provinces or territories that have no HOST member, we contacted HOST collaborators, individuals employed by ministries of health who facilitate access to administrative data and documentation for research purposes. Up

to two individuals from each province and territory were contacted to participate in the study.

Study investigators developed the survey based on earlier research on features of administrative health data.¹⁰ The survey included questions about the years of data available for researcher access and the availability and contents of fields for patient and provider information, patient diagnosis and procedure codes, out-of-province services and services of providers paid by non fee-for-service methods. Physician fee schedules were also consulted as a source of information about remuneration methods.¹¹ Open-ended response categories were used for all survey questions.

Key informants were initially contacted in June 2010. Follow-up questions and online documentation about PSDs was used to clarify responses and to develop additional questions. A second round of questionnaires was sent to the key informants in November 2010 to obtain more detailed information about PSD features.

Secondary data published by CIHI were used to compile additional information about non fee-for-service (i.e. alternate clinical) providers and payments.¹²⁻¹⁴ The data were from reports based on the National Physician Database, which contains aggregate physician payment data from provincial and territories medical services plans. Information about the National Physician Databases and the data collection methodology was previously published.^{12,15}

Ethics approval for the HOST project, which includes the extraction and analysis of administrative health data from the provinces and territories and the collection and reporting of documentation associated with the administrative health data, was obtained from the University of Calgary Research Ethics Board (Ethics Review #E188889). The analysis of publicly available data from CIHI did not require ethics approval.

Results

Key informants from all provinces and territories except New Brunswick responded to the survey, though only

partial information was available from the Northwest Territories. As a result, New Brunswick and Northwest Territories were excluded from the analysis of the survey data.

PSD availability

The survey results indicate that PSDs in Canada contain records from as early as 1970 (see Table 1); the range for the first accessible year of data was 24 years. The Manitoba and Saskatchewan databases contain the oldest records, from the early 1970s. Databases for four provinces hold records from the 1980s. However, Quebec and Alberta reported that some of the earliest records were not easily accessed because they were archived and/or in a format different to more recent records. The other provinces and territories reported that their databases contained records from the 1990s.

Patient and provider information

The survey results also revealed that all PSDs contain unique patient and provider identifiers (Table 1). With appropriate permissions, these identifiers can be used to link the databases to other sources. For example, linkage to a population registry file can be used to obtain dates of coverage by provincial health insurance plans, residence information (e.g. postal code or geographic area), birthdates or age, and sex.

All databases also record provider specialty. The number of specialist categories reported by respondents ranged from about 25 to more than 80. However, broad groupings of family medicine, medical specialties, and surgical specialties were identified in the categories provided by all provinces and territories. At the same time, there was a heterogeneous mix of provider specialties in the "other" category. Depending on the jurisdiction, this category could include nurse practitioners, midwives, pharmacists or other allied health professionals. Most respondents indicated that provider specialty was assigned by each jurisdiction's medical services plan at the time the service record was submitted for payment.

TABLE 1
Major features of physician services databases by province or territory: data availability, patient, provider

Province/ Territory	First year of data accessible to researchers	Patient identifier	Patient demographics ^a	Provider identifier	Provider categories and specialties
British Columbia	1990	✓	✓	✓	50+ categories from family medicine, medical, surgical, other. Multiple specialty fields defined.
Alberta	1982; data prior to 1994 are in a different format	✓	✓	✓	60+ categories from family medicine, medical, surgical, other. Specialty defined by the payment plan.
Saskatchewan	1971	✓	✓	✓	70+ categories from family medicine, medical, surgical, other. Specialty defined by physician certification.
Manitoba	1970	✓	✓	✓	80+ categories from family medicine, medical, surgical, other. Multiple specialty fields defined.
Ontario	1991	✓	✓	✓	35+ categories from family medicine, medical, surgical, other. Multiple specialty fields defined.
Quebec	1983; data prior to 1996 are in a different format	✓	✓	✓	One field distinguishes family physicians from specialists. A second field identifies the type of specialty. 60+ categories are identified from family medicine, medical, surgical, other. Specialty defined by physician training.
Prince Edward Island	1983; Data prior to 1996 are archived	✓	✓	✓	45+ specialty code descriptions within family medicine, medical, surgical, other. Specialty defined by the services provided.
Nova Scotia	1989	✓	✓	✓	50+ categories from family medicine, medical, surgical, other. Billing specialty and main specialty defined.
Newfoundland and Labrador	1995	✓	✓	✓	80+ categories from family medicine, medical, surgical, other. Specialty defined by physician training.
Yukon	1995	✓	✓	✓	25+ categories from family medicine, medical, surgical. Specialty defined by physician certification.
Nunavut	1999	✓	✓	✓	Approximately 70% of records are coded as generalist or specialist physician. The remaining records are missing information about physician specialty.

Note: Incomplete or no survey data was available for New Brunswick and Northwest Territories. As a result, these were excluded from the analysis.

^a Includes date of birth or age, sex, location of residence (e.g. postal code, health region or county)

Diagnosis and procedure information

Table 2 shows information about diagnosis and procedure codes, as identified by the survey respondents. ICD codes were used to record the majority of diagnoses in all jurisdictions. In Saskatchewan and Manitoba, ICD-8^{*} diagnosis codes were primarily used in the 1970s. Three jurisdictions, Manitoba, Alberta and Nunavut, use ICD-9-CM codes[†]. In Yukon, diagnoses are recorded using ICD-9[‡] codes as well as a free-form text format. In Ontario, data contain both ICD-8 and ICD-9 codes, although neither system is used in its entirety. In Saskatchewan, not all ICD-9 codes are used to assign diagnosis.

Respondents from all but three provinces reported that a single diagnosis is recorded for each claim in their PSDs.

For British Columbia, up to three diagnosis fields may be present on some of the claim records. Nova Scotia's database contains three diagnosis codes for selected years. Alberta's database also contains three diagnosis fields, although respondents noted that the second and third fields were not consistently coded in all records. The Yukon and Nunavut databases contain multiple diagnosis fields.

Diagnosis codes were recorded with different degrees of specificity, with three-digit codes being most common. While procedural information was most commonly identified from service fee codes, other procedure coding systems were adopted, including the Canadian Classification of Procedures in both Nova Scotia and Alberta.

Location of services

Survey respondents reported that not all PSDs contain a field or fields to identify location of service (see Table 3); service fee codes and billing location are sometimes required to ascertain service location. However, in all provinces and territories, it is possible to distinguish in-hospital services from those provided in other locations.

PSD inclusions and exclusions

Table 3 also contains survey information about records from out-of-province providers. Respondents from four provinces (Newfoundland and Labrador, Nova Scotia, Manitoba, and British Columbia) reported that these records were contained in a separate database. For

^{*} International Classification of Diseases, Eighth Revision.

[†] International Classification of Diseases, Ninth Revision, Clinical Modification.

[‡] International Classification of Diseases, Ninth Revision.

TABLE 2
Major features of physician services databases in Canada: diagnoses and procedures

Province/ Territory	ICD version	Number of diagnosis fields	Specificity of diagnosis codes (number of digits)	Source of procedure information	Other information about diagnosis/ procedure fields
British Columbia	ICD-9	Most claims contain 1 code, but some primary care physicians record up to 3	Up to 5, but 3 digits are the most common	Fee codes	ICD-9-CM codes are also found in some claims. Some diagnosis codes are specific to the provincial medical services plan.
Alberta	ICD-9-CM	3 (1 before 1994)	Up to 5, but the 5 th digit is not well recorded; 3-digit codes were used before 1994	Canadian Classification of Procedures	
Saskatchewan	ICD-8 until 1978, then ICD-9	1	3	Fee codes	Some diagnostic codes assigned by the province are also used and some ICD-9 codes (including all E-codes and selected other codes) are not used.
Manitoba	ICD-8 until 1979, then ICD-9-CM	1	3	ICD-9-CM and fee codes	
Ontario	Hybrid of ICD-8 and ICD-9	1	3; a 1-digit suffix is added for physiotherapy and chiropractic codes	Fee codes	Not all ICD-8 and -9 diagnosis codes are found in the database.
Quebec	ICD-9	1	4	Province-specific codes	
Prince Edward Island	ICD-9	1	3, except for E-codes and V-codes, which are 5 digits	ICD-9 and fee codes	
Nova Scotia	ICD-9	3 (1 before 1997)	Up to 5; 3-digit codes are the most common and were used before 1997	Modified version of CCP. A single code is recorded	Some E-codes are captured in an "injury diagnosis" field, but the capture rate or completeness is not known.
Newfoundland and Labrador	ICD-9	1	3	Fee codes	
Yukon	ICD-9 + text	2 before 2006, unlimited since then	Up to 5 but most records use only 4	Fee codes	
Nunavut	ICD-9-CM	11	5	None	The databases support the collection of procedure codes, but this information is not currently captured.

Abbreviations: E-codes, external cause of injury codes; ICD-8, International Classification of Diseases, Eighth Revision; ICD-9, International Classification of Diseases, Ninth Revision; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; V-codes, supplemental codes.

Note: Incomplete or no survey data was available for New Brunswick and Northwest Territories. As a result, these were excluded from the analysis.

the remaining provinces and territories, respondents noted that a specific code or field within the PSD could be used to identify out-of-province records.

The collection of records from fee-for-service and non-fee-for-service physicians was the final topic of inquiry. With the exception of Newfoundland and Labrador and of Quebec, respondents indicated that PSDs in all jurisdictions contain records of services provided by non-fee-for-service physicians. However, respondents also indicated that the completeness of capture of records from non-fee-for-service physicians was not consistently known. This might be due to changes in medical service plans over time and/or a lack of documentation about alternate payment plans. Respondents from six jurisdictions reported that PSDs contain a field to distinguish records submitted by fee-for-service physicians from those

submitted by non-fee-for-service physicians. In three provinces, information from a provider registry is needed to distinguish these two types of records.

CIHI data on physician remuneration methods

The secondary data from CIHI were used to investigate physician remuneration methods across jurisdictions, which may affect the completeness of PSDs. Data from the territories were not consistently available and are therefore not reported. In Figure 1, the percentage of full-time equivalent physicians remunerated by non-fee-for-service (i.e. alternate clinical) payment methods are reported for fiscal years 1999/2000 and 2005/2006; the last year is the most recent available from CIHI. This percentage increased in all provinces, except for British Columbia and for

Newfoundland and Labrador. The largest absolute increase occurred in New Brunswick (17.3%) and Prince Edward Island (15.0%). When the data from the four Atlantic provinces were combined, the percentage of full-time equivalent physicians remunerated by alternate clinical payments rose from 20.3% to 25.6%. Saskatchewan also saw a large absolute increase (6.5%). Figure 2 provides data about alternative clinical payments to physicians in fiscal years 1999/2000 and 2008/2009. Overall, payments in the four Atlantic provinces increased from 23.8% to 39.8%. Large increases between the two study years were also observed in Ontario and Saskatchewan.

Discussion

We identified only one other published paper that systematically documented the features of PSDs in Canada; it focused on

TABLE 3
Major features of physician services databases in Canada: service location and completeness

Province/ Territory	Location of service categories	Out-of-province services	Shadow-billed records	Shadow-billing indicator
British Columbia	Province and out-of-country locations are identified. Service locations including hospitals and clinics are available from 1990.	Recorded in a separate database	Yes, but completeness is unknown	Yes. As of 1999 shadow-billed claims can be identified using a flag.
Alberta	Service locations are identified from address information.	Identified in one field in the database	Yes, but completeness is unknown	Yes
Saskatchewan	Office, hospital inpatient, hospital outpatient, home, other, location not indicated, emergency room physician. Fee codes are also used to identify services provided in hospital. Location of services became a required field in the 1980s, but the exact date is not known. This field is not validated.	Identified by a field in the database	Yes, but completeness is unknown	Yes
Manitoba	Hospital location categories are identified in one field. Services to other locations, including personal care homes and patient home are identified from fee codes. Clinic locations are identified from the billing location.	Collected in a separate database. Available since 1993/1994	Yes, but completeness is unknown	No. Shadow-billed claims can be identified using information contained in the provider registry.
Ontario	In the current data, there is no field for location of service. Locations are identified from fee codes and/or institution numbers. A hospital master number is recorded for services provided in hospital.	Identified by a numeric code in the database or by the fee code or physician number	Yes, but completeness is unknown	Yes
Quebec	Two primary locations: private cabinet (e.g. office/clinic) and establishment (e.g. hospital). For establishments, there are 40+ location categories including private firms, hospitals, laboratory diagnostic radiology, office of physiotherapy, home centres for children and youth, federal agencies, universities, private clinics, private labs orthotics-prosthetics, detention centres.	Identified by a numeric code in the database	No	No
Prince Edward Island	25 codes are currently used: office, home visit, inpatient, outpatient, other office, day surgery, specialty clinic, community care facility, other site, UPEI clinic, detox centres, First Patient, inpatient radiology, night clinic, outpatient radiology, visiting specialist in Prince County Hospital, visiting specialist in Queen Elizabeth hospital, Saturday/Sunday office, radiology, provider in any facility type, radiology emergency, walk-in clinic, public dental facility, private dental facility, public health hygienist.	Identified by a numeric code in the database	Yes, but completeness is unknown. Effective July 1, 2008, the Clinical Work Incentive (an incentive to shadow bill) was introduced, at which time shadow-billing has become more complete	No. Shadow-billed claims can be identified from the physician billing or specialty number.
Nova Scotia	Office, correctional centre, home hospital care, patient's home, hospital, nursing home. Hospital locations include detox, emergency, intensive care, inpatient, neonatal unit, outpatient.	Collected in a separate database	Yes, but completeness is unknown	Yes, from 1997 onward.
Newfoundland and Labrador	Home, office, inpatient, outpatient, emergency department.	Collected in a separate database	No	No
Yukon	Office/practitioner office, patient's home, hospital inpatient, hospital outpatient, lab, surgery specialty clinic, community care facility, other, out of town clinic, nursing home, injection, anesthesia, assist surgery, admit, maternity, jail.	Identified in one field in the database	Yes, but completeness is unknown	Yes
Nunavut	No field for location of service.	Identified by a numeric code in the database	No	No

Abbreviation: UPEI, University of Prince Edward Island.

Note: Incomplete or no survey data was available for New Brunswick and Northwest Territories. As a result, these were excluded from the analysis.

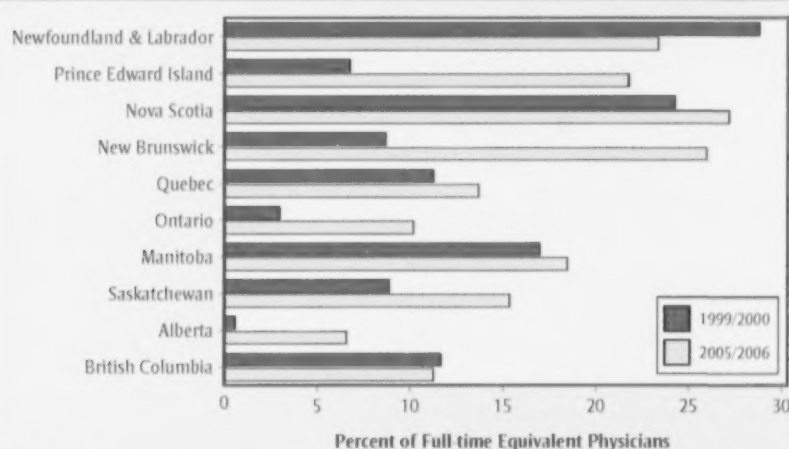
the Saskatchewan database.¹⁶ However, previous research that compared prescription drug administrative databases in several Canadian provinces found differences in patient, provider and drug features.¹⁰ These findings are consistent with the findings of the current study, which revealed heterogeneity in many features of PSDs in Canada, including the years of available data, classification of provider

specialty, database inclusions and exclusions, and coding of diagnoses, procedures and service locations.

PSDs have a tremendous potential to benefit population health and health services research and surveillance initiatives in Canada. The Canadian Chronic Disease Surveillance System uses administrative health databases to provide

comparable, longitudinal data on chronic disease prevalence and incidence. This is used to support provincial and territorial surveillance efforts. Statistic Canada's Longitudinal Health and Administrative Data Initiative links administrative health databases with population health survey data, including data from the National Population Health Survey and Canadian Community Health Survey, to facilitate

FIGURE 1
Full-time equivalent physicians receiving non-fee-for-service
(alternate clinical) payments, by province, 1999/2000 and 2005/2006



Source: Canadian Institute for Health Information.^{11,18}

pan-Canadian research about determinants of health, health outcomes and their relationships.¹⁷

However, differences in PSDs across Canada are an important consideration for comparability of the findings from research and surveillance studies. Changes in disease prevalence estimates over time may be due, in part, to measurement artifact arising from changes in ICD coding systems rather than true change in the population distribution of disease.¹⁸ The incomplete capture of services by non-fee-for-service physicians may result in biased estimates of trends over time and differences across health regions.¹⁹ The number of years of available data might influence the results of studies about duration of disease exposure and time to disease onset.²⁰ Text diagnosis fields, such as those found in the Yukon PSD, may require the use of data mining techniques to assign diagnosis codes,²¹ a different methodology than would be used in other jurisdictions to ascertain disease cases.

Some studies may not be feasible for all Canadian provinces and territories because of the differences in data coding systems. For example, some forms of arthritis cannot be identified using the first three digits of ICD-9.²² Ontario and Saskatchewan PSDs do not contain all codes from either the ICD-8 or ICD-9 systems; incomplete codes may result

in missing observations. Heterogeneity in coding systems may affect the consistent identification of some types of procedures, such as casting or immobilization procedures, which are used to ascertain fracture cases^{23,24} or endoscopy or colonoscopy procedures, which have been the focus of previous pan-Canadian research.¹¹

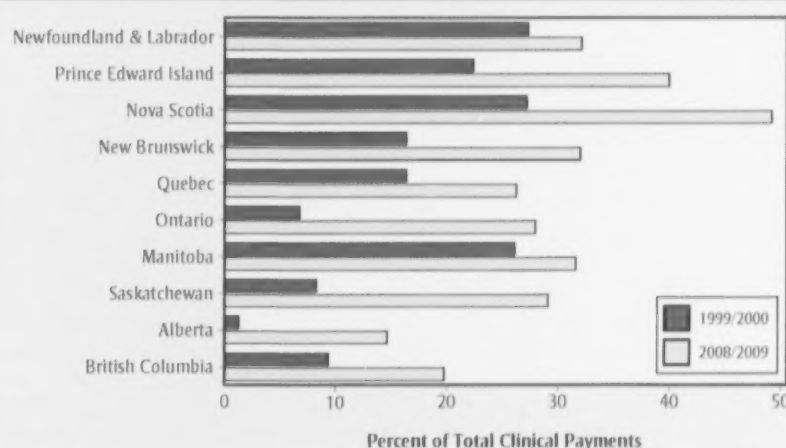
Strengths and limitations of the study

While our study is the first to document and report the features of PSDs from many provinces and territories, it does have

some limitations. The study relied on a purposive sample; the key informants may not have had complete information about features of PSDs over time or across the geographic regions of a province or territory. A second limitation is that the quality of the data associated with different features was not investigated.²⁵ For example, this study did not examine accuracy or completeness of fields containing location of service codes.

Our study suggests a rich set of opportunities to examine further the use and comparability of PSDs in pan-Canadian research and surveillance initiatives. Previous research about the potential bias caused by the length of the observation period and incompleteness of data on prevalence and incidence estimation has often focused on cancer registries and on data from a single jurisdiction.^{26,27} Computer simulation and statistical modeling techniques that have been proposed to estimate or adjust for these effects^{28,29} could be extended to multiple jurisdictions. Methodological investigations about the utility of other administrative databases, such as prescription drug databases, to estimate the completeness of PSDs for chronic disease surveillance⁸ could also be used for comparisons across many jurisdictions. A recent study about methods to ascertain chronic disease cases in administrative health databases emphasized the need to assess the validity of diagnosis codes

FIGURE 2
Non-fee-for-service (alternate clinical) payments to physicians,
by province, 1999/2000 and 2008/2009



Source: Canadian Institute for Health Information.¹⁷

across populations and over time to ensure the generalizability of case-detection algorithms.³⁰ There are other features of PSDs that require investigation, including data access procedures, service fee codes, and processes for data linkage. For example, substantial differences have been observed in service fees for colonoscopy and endoscopy using provincial and territorial fee schedules.^{31,32} There may also be differences in the types of procedures and services for which fee codes have been developed. While there are an increasing number of studies that link PSDs to other administrative, clinical and population-based survey data sources,^{31,32} we did not consider how the capability to conduct these linkages might vary across provinces and territories.

In summary, this study has demonstrated differences across provinces and territories in a number of PSDs features. This may affect the comparability of pan-Canadian research and surveillance. Studies that investigate the potential impact of these differences will benefit Canadian researchers, epidemiologists and health care decision makers.

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References

1. Clotey C, Mo F, LeBrun B, Mickelson P, Niles J, Robbins G. The development of the National Diabetes Surveillance System (NDSS) in Canada. *Chronic Dis Can.* 2001;22:67-9.
2. Khan L, Mincemoyer S, Gabbay RA. Diabetes registries: where we are and where are we headed? *Diabetes Technol Ther.* 2009;11:255-62.
3. Dai S, Robitaille C, Bancej C, Loukine L, Waters C, Baclic O. Executive summary report from the Canadian Chronic Disease Surveillance System: hypertension in Canada, 2010. *Chronic Dis Can.* 2010;31:46-7.
4. Bernatsky S, Joseph L, Pineau CA, B  lisle P, Boivin JF, Banerjee D, et al. Estimating the prevalence of polymyositis and dermatomyositis from administrative data: age, sex, and regional differences. *Ann Rheum Dis.* 2009;68:1192-6.
5. Bernstein CN, Wajda A, Svenson LW et al. The epidemiology of inflammatory bowel disease in Canada: a population based study. *Am J Gastroenterol.* 2006;101:1559-68.
6. Kisely S, Lin E, Lesage A, MacKenzie A, Koehoorn M, Jackson M, et al. Use of administrative data for the surveillance of mental disorders in 5 provinces. *Can J Psychiatry.* 2009;54:571-5.
7. Campbell N, Onysko J; Canadian Hypertension Education Program; Outcomes Research Task Force. The Outcomes Research Task Force and the Canadian Hypertension Education Program. *Can J Cardiol.* 2006;22:556-8.
8. Alshammari AM, Hux JE. The impact of non fee for service reimbursement on chronic disease surveillance using administrative data. *Can J Public Health.* 2009;100:472-4.
9. Campbell N, Chen G. Canadian efforts to prevent and control hypertension. *Can J Cardiol.* 2010;26(Suppl C):14C-17C.
10. Miller E, Blatman B, Einarson TR. A survey of population based drug databases in Canada. *CMAJ.* 1996;154:1855-64.
11. Roth LS, Adams PC. Variation in physician reimbursement for endoscopy across Canada. *Can J Gastroenterol.* 2009;23:503-5.
12. Canadian Institute for Health Information. National physician database, 2008-2009. Ottawa (ON): Canadian Institute for Health Information; 2010.
13. Canadian Institute for Health Information. Physicians in Canada: the status of alternate payment programs, 1999-2000. Ottawa (ON): Canadian Institute for Health Information; 2001.
14. Canadian Institute for Health Information. Physicians in Canada: the status of alternative payment programs, 2005-2006. Ottawa (ON): Canadian Institute for Health Information; 2008.
15. Canadian Institute for Health Information. Profiling physicians by payment program: a closer look at three provinces. Ottawa (ON): Canadian Institute for Health Information; 2010.
16. Downey W, Beck C, McNutt M, Stang M, Osei W, Nichol J. Health databases in Saskatchewan. In: Strom BL, ed. *Pharmacoeconomics*, 3rd ed. New York: Wiley; 2000;325-45.
17. Statistics Canada. About the longitudinal health and administrative data initiative. Health Research Working Paper Series [Internet]. Ottawa (ON): Statistics Canada; 2011 [accessed 2011 Nov 28]. Available from: <http://www.statcan.gc.ca/pub/82-622-x/2011008/intro-eng.htm>

18. Statistics Canada. Comparability of ICD 10 and ICD 9 for mortality statistics in Canada. 84 548 XIE [Internet]. Ottawa (ON): Statistics Canada; 2005 [accessed 2011 Nov 28]. Available from: [http://www.statcan.gc.ca/pub/84 548 x/84 548 x2005001 eng.htm](http://www.statcan.gc.ca/pub/84%20548%20XIE/84%20548%20XIE005001-eng.htm)
19. Parkin DM, Bray F. Evaluation of data quality in the cancer registry: principles and methods Part II. Completeness. *Eur J Cancer*. 2009;45:756-64.
20. Cox E, Martin BC, Van Staa T, Garbe E, Siebert U, Johnson ML. Good research practices for comparative effectiveness research: approaches to mitigate bias and confounding in the design of nonrandomized studies of treatment effects using secondary data sources: The International Society for Pharmacoeconomics and Outcomes Research Good Research Practices for Retrospective Database Analysis Task Force Report Part II. Value in Health. 2009;12:1053-61.
21. Mullins IM, Siadat MS, Lyman J, Scully K, Garrett CT, Miller WG, et al. Data mining and clinical data repositories: insights from a 667,000 patient data set. *Comput Biol Med*. 2006;36:1351-77.
22. Katz JN, Barrett J, Liang MH, Bacon AM, Kaplan H, Kieval RI, et al. Sensitivity and positive predictive value of Medicare Part B physician claims for rheumatologic diagnoses and procedures. *Arthritis Rheum*. 1997;40:1594-1600.
23. Leslie WD, Tsang JF, Lix LM. Validation of ten year fracture risk prediction: a clinical cohort study from the Manitoba Bone Density Program. *Bone* 2008;43:667-71.
24. Jean S, Candas B, Belzile E, Morin S, Bessette L, Dodin S, et al. Algorithms can be used to identify fragility fracture cases in physician claims databases. *Osteoporos Int*. 2012;23:483-501.
25. Karr AF, Sanil AP, Banks DL. Data quality: a statistical perspective. *Stat Methodol*. 2006;3:137-73.
26. McClish D, Penberthy L. Using multivariate capture recapture techniques and statewide hospital discharge data to assess the validity of a cancer registry for epidemiologic use. *Health Serv Outcomes Res Methodol*. 2004;5:141-52.
27. Capocaccia R, de Angelis R. Estimating the completeness of prevalence based on cancer registry data. *Stat Med*. 1997;16:425-40.
28. Silcocks PB, Robinson D. Simulation modelling to validate the flow method for estimating completeness of case ascertainment by cancer registries. *J Public Health*. 2007;29:455-62.
29. Bernatsky S, Joseph L, Belisle P, Boivin JF, Rajan R, Moore A, et al. Bayesian modelling of imperfect ascertainment methods in cancer studies. *Stat Med*. 2005;24:2365-79.
30. Manuel DG, Rosella LC, Stukel TA. Importance of accurately identifying disease in studies using electronic health records. *BMJ*. 2010;341:c4226.
31. Lix LM, Yogendran MS, Shaw SY, Burchill C, Metge C, Bond R. Population based data sources for chronic disease surveillance. *Chron Dis Can*. 2008;29:31-8.
32. Muhajarine N, Mustard C, Roos LL, Young TK, Gelskey DE. Comparison of survey and physician claims data for detecting hypertension. *J Clin Epidemiol*. 1997;50:711-8.
33. Roos LL, Brownell M, Lix L, Roos NP, Walld R, MacWilliam L. From health research to social research: privacy, methods, approaches. *Soc Sci Med*. 2008;66:117-29.

Using national surveys for mental health surveillance of individuals with intellectual disabilities in Canada

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Abstract

Introduction: Individuals with intellectual disabilities have a higher prevalence of health problems, including psychiatric and behavioural conditions, than the general population. However, there is little population-based information in Canada about individuals with a dual diagnosis of psychiatric disorder and intellectual impairment. The aim of this study was to determine whether the 2005 Canadian Community Health Survey (CCHS) and the 2006 Participation and Activity Limitation Survey (PALS) could be used to estimate the prevalence of dual diagnosis in Canada.

Methods: We undertook a secondary analysis of two population-based surveys to determine if these could be used to estimate the prevalence of psychiatric or behavioural conditions among adults with intellectual disabilities in Canada.

Results: The surveys reflect prevalence estimates of intellectual disabilities (CCHS: 0.2% and PALS: 0.5%) that are considerably lower than those published in the literature. While it was possible to calculate the proportion of individuals with a dual diagnosis (CCHS: 30.6% and PALS: 44.3%), the surveys were of limited use for detailed analyses. The estimates of prevalence derived from the surveys, especially from the CCHS, were of unacceptable quality due to high sampling variability and selection bias.

Conclusion: The estimates should be interpreted with caution due to concerns regarding the representativeness of the sample with intellectual disabilities in the national surveys.

Keywords: mental retardation, mental disorders, health surveys, health services research

Introduction

Intellectual disabilities can be defined as life-long conditions that present before the age of 18 years that are characterized by limitations in intellectual functioning and adaptive behaviour.¹ Intellectual disabilities affect up to 3% of the population.² Most studies have shown that intellectual disabilities affect more males than females.^{3,4} The prevalence of diagnosed intellectual disabilities

increases with age among children and adolescents.² However, studies of prevalence among adults consistently report rates below 1%.⁵ Compared to the general population, individuals with intellectual disabilities have a higher prevalence of health problems,^{6,7} including a psychiatric or behavioural condition.⁸ In Canada, the term "dual diagnosis," as defined by the Canadian Mental Health Association*, usually refers to an individual with both a mental illness and an

intellectual disability. Research suggests that the proportion of people with intellectual disabilities who have co-morbid psychiatric or behavioural conditions ranges from 14% to 64% depending on the population studied and the diagnostic criteria used.⁹⁻¹⁴

Although up to 3% of Canadians may have an intellectual disability, no studies have examined the feasibility of using national health surveys to research this population. In response to this, we examined two national health surveys, Canadian Community Health Survey (CCHS) and Participation and Activity Limitation Survey (PALS), to determine if they could be used for mental health surveillance among Canadians with an intellectual disability to potentially aid service and policy planners in learning more about this population.

Methods

We conducted a secondary analysis of two population-based surveys, CCHS and PALS. The CCHS, Cycle 3.1 (2005), is a cross-sectional survey of 130 000 Canadians aged 12 years and over, representing residents of all provinces and territories.¹⁵ A multistage stratified cluster sampling design is used in the survey. The PALS (2006) is a cross-sectional survey of 47 500 individuals¹⁶ that has a two-phase stratified sample design. The sampling frame for the second phase comprised all people who reported activity limitations

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on the 2006 Canadian census. A separate dataset containing demographic information about individuals who completed the census but did not indicate activity limitations was combined with the PALS dataset. For the PALS, proxy respondents were allowed when the selected respondent was not present during the duration of the survey, did not speak English or French, or could not participate in the survey due to a physical or mental condition.¹⁶ In the CCHS, proxy respondents were not allowed for certain questions. In both the CCHS and PALS, individuals living on Indian Reserves, Canadian Forces Bases, and institutions were excluded from the sampling frame.^{15,16}

Permission was obtained from Statistics Canada to use the survey master files at the Queen's University Research Data Centre. Ethical approval was obtained from the Queen's University Research Ethics Board.

Measurement of dual diagnosis

To estimate the proportion of adults with intellectual disabilities, the CCHS asked: "Do you have autism or any other developmental disorder such as Down's syndrome, Asperger's syndrome or Rett syndrome?"¹⁷ The PALS, in turn, asked the question: "Has a doctor, psychologist or other health professional ever said that you had a developmental disability or disorder?"¹⁸ Conditions such as Down syndrome, autism, Asperger syndrome and mental impairment due to a lack of oxygen at birth were included as examples for the PALS respondents.

To classify an individual as having a dual diagnosis, the question assessing intellectual disability was cross-tabulated with questions in the survey that assessed self-reported mental illness. In the CCHS, mental illness was defined as having one or more of the following conditions: schizophrenia; mood disorders—depression, bipolar disorder, mania or dysthymia; anxiety disorders—phobia, obsessive-compulsive disorder or panic disorder; and eating disorders—anorexia or bulimia.¹⁷ In the PALS, mental illness was assessed by asking respondents about emotional, psychological or psychiatric conditions

that had lasted or were expected to last for 6 months or more.¹⁸ These conditions included phobias, depression, schizophrenia, and drinking/drug problems.

Measurement of demographic variables

The analysis included data regarding respondents' sex, age and province of residence. Only individuals aged 18 years or older were included. Data regarding province of residence were grouped to create five geographical areas: British Columbia and Alberta, Saskatchewan and Manitoba, Ontario, Quebec, and the Atlantic Provinces (New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador). Yukon, Northwest Territories and Nunavut were excluded due to low cell counts.

Data management

For both surveys, responses where the answer was "refusal," "don't know" or "not stated" were not included in the analysis. SPSS software version 6.0 for Sun Ray Microsystems was used to analyze the national surveys. Data with cell counts less than 5 or 10 for the CCHS or PALS, respectively, were suppressed and the estimates not released due to confidentiality. Appropriate population weights were applied to the data. In order to calculate the 95% confidence intervals (CIs) for the prevalence estimates in the CCHS, bootstrap weights and Statistics Canada's BOOTVAR macros were used for SPSS software version 14.0 (SPSS, Chicago, IL). For the PALS, bootstrap weights were used for STATA version 10.0 software (StataCorp LP, College Station, Texas).

When assessing data quality, the coefficient of variation was calculated for each estimate by dividing the standard error of the estimate by the estimate itself, in accordance with Statistics Canada data release procedures. The quality of the estimate was quantified by Statistics Canada based on the size of the coefficient of variation as a small value corresponds to smaller variability in the sample population.¹⁵ Estimates with coefficient of variation scores between 16.5% and 33.3% should be considered with caution due to the high sampling variability. Estimates with

coefficient of variation scores greater than 33.3% are not recommended for release by Statistics Canada.^{15,16}

Data analysis

We calculated the proportion of individuals with an intellectual disability in the whole population. Age- and sex-specific proportions of intellectual disability by geographic region were determined. Proportions were also calculated for each overall geographical region. The percentage of individuals with an intellectual disability who have a co-morbid psychiatric or behavioural condition was also determined, along with 95% CIs.

Results

Prevalence of intellectual disabilities in Canada

Using the CCHS, Cycle 3.1 (2005), 51 655 or 0.2% (0.17%–0.26%) of the Canadian adult population is estimated to have an intellectual disability (Table 1). The estimate is higher when using the PALS (2006): 0.5% (0.43%–0.56%) representing 112 919 individuals. In the CCHS, the prevalence of intellectual disability was 0.2% for both men (0.18%–0.30%) and women (0.12%–0.25%, high sampling variability). These proportions are higher in the PALS, where 0.6% (0.47%–0.68%) of the men and 0.4% (0.34%–0.50%) of the women have an intellectual disability. When analyzed by age, the proportion of individuals with an intellectual disability is higher in the PALS as compared to the CCHS for most age groups. In the PALS, 35% of those with an intellectual disability are under 35 years of age. A significantly lower proportion of individuals in the oldest age group (65+ years old) have an intellectual disability when compared to the other age groups in the PALS.

The geographical distribution of individuals with an intellectual disability across Canada shows a similar pattern in both surveys, but the CCHS estimates tended to be of poor quality. In the PALS, the estimates in British Columbia and Alberta, Saskatchewan and Manitoba, Ontario, and the Maritime Provinces ranged from 0.5%–0.6%. Individuals residing in Quebec had the

TABLE 1
Proportion of Canadian population with an intellectual disability by sex, age and geographical area: CCHS (2005) and PALS (2006)

	CCHS		PALS	
	Number	% (95% CI)	Number	% (95% CI)
Sex				
Male	28 484	0.2 (0.18, 0.30)	63 582	0.6 (0.47, 0.68)
Female	23 171	0.2* (0.12, 0.25)	49 337	0.4 (0.34, 0.50)
Age, years				
18–19	—	—	6 288	0.8 (0.55, 1.00)
20–24	12 351	0.6* (0.32, 0.79)	13 871	0.7 (0.59, 0.82)
25–34	14 606	0.4* (0.20, 0.50)	19 798	0.5 (0.39, 0.65)
35–44	8 404	0.2* (0.10, 0.23)	21 603	0.5 (0.37, 0.57)
45–54	8 751	0.2* (0.09, 0.28)	25 623	0.5 (0.37, 0.72)
55–64	1 436	< 0.1* (0.01, 0.07)	18 858	0.6* (0.27, 0.85)
65+	3 145	< 0.1* (0.03, 0.13)	6 879	0.2* (0.09, 0.28)
Geographical area				
Newfoundland, Prince Edward Island, Nova Scotia and New Brunswick	4 931	0.3* (0.15, 0.39)	11 027	0.6 (0.56, 0.74)
Quebec	9 623	0.2* (0.09, 0.24)	21 962	0.4 (0.28, 0.49)
Ontario	19 377	0.2* (0.13, 0.28)	45 913	0.5 (0.38, 0.67)
Saskatchewan and Manitoba	4 118	0.3* (0.13, 0.41)	9 054	0.6 (0.51, 0.76)
British Columbia and Alberta	13 607	0.2* (0.15, 0.33)	24 963	0.5 (0.38, 0.56)
Total	51 655	0.2 (0.17, 0.26)	112 919	0.5 (0.43, 0.56)

Abbreviations: CCHS, Canadian Community Health Survey; CI, confidence interval; PALS, Participation and Activity Limitation Survey.

Note: Estimates are adjusted using bootstrap weights.

* The estimate is considered to be of poor quality due to high sampling variability.

lowest prevalence estimate (0.4%), which was statistically significant when compared to the estimates from other geographical areas.

Dual diagnosis in Canada

The CCHS estimates the proportion of adults with an intellectual disability who have a dual diagnosis to be 30.6% (95% CI: 21.1%–40.0%) representing 15 783 Canadians (Table 2). This proportion was slightly higher in the PALS at 44.3% (95% CI: 37.5%–51.1%) representing 50 053 Canadians. The remaining CCHS estimates were of poor quality with high coefficient of variation scores limiting their publication. In the PALS, the prevalence estimates of dual diagnosis were 46.9% (95% CI: 37.1%–56.7%) for men and 41.0% (95% CI: 31.5%–50.5%) for women. However, the confidence intervals were very wide, indicating poor precision. The proportion of individuals with a dual diagnosis was lower in the youngest age group (aged 18–19 years), although this was not statistically significant. In addition, the estimate was of marginal or poor quality. The remaining estimates did not differ significantly from each other. The

proportion of individuals with a dual diagnosis ranged from 37% to 49% by geographical area and the estimates were not statistically significantly different from each other.

Quality of survey estimates

A substantial number of the estimates derived from the national surveys were of poor or unacceptable quality due to high sampling variability, and therefore conclusions could not be drawn from them. This was especially true for the CCHS data where only 3 of the estimates were of reportable quality, 19 were of marginal or poor quality and 6 were of unacceptable quality and could not be released. In comparison, 27 estimates from the PALS were of reportable quality with only 5 being of marginal or poor quality.

Discussion

Identifying the population with intellectual disabilities

Both the CCHS and PALS reported a prevalence of intellectual disabilities considerably lower than the reported

population prevalence, especially when compared to the estimates when children are included. A recent meta-analysis of 52 studies (cohort, case control, cross-sectional studies) found the prevalence of intellectual disability to be 1.04%, with lower rates among adults (0.49%).⁵ According to the CCHS, 0.2% of Canadians reported an intellectual disability, while in the PALS this prevalence estimate was 0.5%. The prevalence estimates were dissimilar due to differences in the sample populations participating in the surveys and the manner in which information was collected for the surveys. The PALS included individuals who reported activity limitations on the Canadian census, while the CCHS was based on the selected households that replied to the survey.

Additionally, the PALS could have increased the likelihood of a person with an intellectual disability being included in the survey as it allowed proxy respondents to complete the entire survey on behalf of the selected individuals. In comparison, the CCHS restricted the type of questions that could be answered by proxy respondents. The proxy respondents needed to be familiar with the challenges

TABLE 2
Proportion of adults with intellectual disabilities with a dual diagnosis by sex, age and geographical area: CCHS (2005) and PALS (2006)

	CCHS		PALS	
	Number	% (95% CI)	Number	% (95% CI)
Sex				
Male	8 594	30.2* (19.8, 40.5)	29 826	46.9 (37.1, 56.7)
Female	7 189	31.0* (15.1, 46.9)	20 227	41.0 (31.5, 50.5)
Age, years				
18-19	—	—	1 886	30.0* (17.2, 42.8)
20-24	—	—	5 599	40.4 (32.5, 48.3)
25-34	—	—	9 063	45.8 (33.0, 58.6)
35-44	2 626	31.3* (14.8, 47.7)	10 916	50.5 (40.0, 61.1)
45-54	3 936	45.0* (18.1, 71.9)	12 418	48.5* (31.2, 65.7)
55+	—	—	10 171	39.5* (20.5, 58.6)
Geographical area				
Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick	1 970	40.0* (17.8, 62.1)	4 021	36.5 (29.5, 43.5)
Quebec	—	—	10 066	45.8 (31.1, 60.6)
Ontario	4 266	22.0* (8.2, 35.9)	19 758	43.0 (29.3, 56.8)
Saskatchewan, Manitoba	5 914	43.5* (24.4, 62.5)	3 884	42.9 (32.2, 53.7)
British Columbia, Alberta	—	—	12 323	49.4 (39.8, 58.9)
Total	15 783	30.6 (21.1, 40.0)	50 053	44.3 (37.5, 51.1)

Abbreviations: CCHS, Canadian Community Health Survey; CI, confidence interval; PALS, Participation and Activity Limitation Survey.

Note: Estimates are adjusted using bootstrap weights.

* The estimate is considered of poor quality due to high sampling variability.

and difficulties the person faced due to the disability.¹⁶ Overall, 12.1 % of the sample over the age of 15 years completed the PALS using a proxy respondent. Close to 60 % of the subjects who completed the survey by a proxy respondent cited an inability to participate due to a physical or mental condition.¹⁶ In contrast, less than 2 % of the sample in the CCHS completed the survey using a proxy respondent.¹⁷

The prevalence estimates presented by CCHS and PALS data are likely lower than expected due to the population frame used. Both national surveys excluded individuals living in institutions and long-term care facilities. In 2003, an estimated 20 000 individuals with intellectual disabilities resided in health-related institutions across Canada and an additional 12 000 lived in institutional facilities specifically for people with intellectual disabilities.²⁰ Therefore, it is likely that a large portion of the population with intellectual disabilities was ineligible to participate in the national surveys, thereby lowering the estimate of the prevalence of intellectual disabilities in Canada from such surveys.

However, both of the national surveys found that the estimates of the proportion of adults with a dual diagnosis are similar to those reported in the literature. In studies that surveyed service recipients, 28 % to 31 % of individuals with intellectual disabilities had a concurrent mental health problem.²¹⁻²³

Use of national surveys for mental health surveillance

Although it was possible to determine the overall prevalence of intellectual disabilities among adults in the CCHS (0.2 %) and in the PALS (0.5 %), it is possible that the samples were biased because of the low prevalence of intellectual disability detected and the method of respondent selection, raising concerns about the generalizability of the estimates. The prevalence rates of intellectual disability by sex, age and geography were of poor quality from the CCHS due to high sampling variability and could not be reported. Some prevalence rates (sex and geography) could be determined from the PALS, although age comparisons, particularly in the older age groups, were also of poor quality. Both surveys were able to determine the overall

prevalence of dual diagnosis but were of limited use for more detailed analyses. Of the two surveys, the best approach for estimating the prevalence of intellectual disabilities and the proportion of these individuals with a dual diagnosis was through the PALS. These estimates are of higher quality because they had lower coefficients of variation, and the survey included proxy respondents, which potentially allowed the inclusion of people with severe intellectual disabilities in the survey. The data from the CCHS were mostly of poor quality, which limits the use of this survey.

Limitations of the surveys

Individuals with intellectual disabilities may be under-represented by the national surveys as the sampling frames exclude those who lived in institutions, such as long-term care facilities and hospitals.^{15,16} The sampling frame used in the PALS may cause selection bias, as individuals with activity limitations who live in the community are chosen to participate. Moreover, individuals who do not indicate having activity limitations on the census are not included in the PALS sampling frame. Therefore, individuals with a mild

intellectual disability and those who are not aware of their limitations may be missed. As a result, individuals with a very mild intellectual disability or a severe or profound intellectual disability may be missed, while those with mild or moderate intellectual disability may be over-represented.

Additionally, questions used to assess intellectual disability and mental health varied across the surveys. As a result, differing populations could have been classified as having an intellectual disability and co-morbid psychiatric or behavioural conditions, hence limiting comparability across the surveys. The level of intellectual disability, which is related to the prevalence of psychopathology,^{17,22,28} was not assessed in any of the surveys.

Another limitation of using the national survey data is the inability to investigate numerous factors associated with intellectual disabilities and mental health due to low cell counts and data suppression. However, the major limitation of using national survey data is the quality of the estimates that are produced as measured by the coefficient of variation. Some of the reported estimates from the national surveys were of marginal, poor or unacceptable quality due to high sampling variability, which would limit the generalizability of the results. This limited the conclusions that could have been made about the data, particularly those in the CCHS.

Strengths of the study

To the best of our knowledge, this is the first study to examine data from two national surveys—CCHS (2005) and PALS (2006)—to assess the prevalence of intellectual disabilities and dual diagnosis in Canada. The results highlight the gaps in knowledge regarding the prevalence of intellectual disabilities in Canada and the proportion of these individuals with a dual diagnosis. However, selection bias and data quality must be taken into account when applying the results to the population with intellectual disabilities. Secondly, the variables used in the survey are available

and accessible for analysis and differences across future surveys can be examined. As a result, this study can be easily reproduced.

Conclusion

Psychiatric and behavioural conditions are present in about one-third of the population with intellectual disabilities, as shown by the two surveys examined. Among the surveys, the PALS presented the highest quality of data regarding the population with a dual diagnosis. It has recently been reported that the PALS will not be funded by Human Resources and Skills Development Canada in 2011, and a new strategy for monitoring people with disabilities is to replace the survey.^{25,26} The collection of data on individuals with intellectual disabilities is of importance as Canada ratified the United Nations Convention on the Rights of Persons with Disabilities in 2010.¹⁷ The new strategy should ensure that subgroups of the population with disabilities, such as individuals with intellectual disabilities, are properly identified and that their health status is validly and reliably ascertained. Proxy responses from family members or caregivers should be allowed. In addition, the new strategy should consider identifying individuals residing in institutions. Over-sampling of adults whose disabilities onset in childhood will be required to ensure adequate representation in the surveys. Tools that have been validated to assess psychopathology among adults with intellectual disabilities may be considered, especially among those individuals with moderate or severe intellectual disability.

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References

1. Schalock RL, Luckasson R. American Association on Mental Retardation's definition, classification, and system of supports and its relation to international trends and issues in the field of intellectual disabilities. *J Policy Pract Intellect Disabilities*. 2004;1(3/4):136-46.
2. Roelvelde N, Zieffhuis GA, Gabreels F. The prevalence of mental retardation: a critical review of recent literature. *Dev Med Child Neurol*. 1997;39(2):125-32.
3. Partington M, Mowat D, Einfeld S, Tonge R, Turner G. Genes on the X chromosome are important in undiagnosed mental retardation. *Am J Med Genet*. 2000;92:57-64.
4. Leonard H, Peterson B, Bower C, Sanders R. Prevalence of intellectual disability in Western Australia. *Pediatr Perinat Epidemiol*. 2003;17(1):58-67.
5. Maulik PK, Mascarenhas MN, Mathers CD, Dua T, Saxena S. Prevalence of intellectual disability: a meta-analysis of population-based studies. *Res Dev Disabil*. 2011;32(2):419-36.
6. Bittles AH, Peterson BA, Sullivan SG, Hussain R, Glasson EJ, Montgomery PD. The influence of intellectual disability on life expectancy. *J Gerontol A Biol Sci Med Sci*. 2002;57A(7):M470-2.
7. van Schrojenstein Lantman de Valk HM, van den Akker M, Maaskant MA, Haveman MJ, Urlings HF, Kessels AG, et al. Prevalence and incidence of health problems in people with intellectual disability. *J Intellect Disabil Res*. 1997;41(1):42-51.
8. Yu D, Atkinson L. Developmental disability with and without psychiatric involvement: prevalence estimates for Ontario. *J Devel Disabil*. 1993; 2(1):92-9.

9. Deb S, Thomas M, Bright C. Mental disorder in adults with intellectual disability. I: prevalence of functional psychiatric illness among a community based population aged between 16 and 64 years. *J Intellect Disabil Res.* 2001;45(6):495-505.
10. Jacobson JW. Problem behavior and psychiatric impairment within a developmentally disabled population II: behavior severity. *App Res Ment Retard.* 1982;3:369-81.
11. Bhaumik S, Tyrer FC, McGrother C, Ganghadaran SK. Psychiatric service use and psychiatric disorders in adults with intellectual disability. *J Intellect Disabil Res.* 2008;52(11):986-95.
12. Cooper SA, Smiley E, Morrison J, Williamson A, Allan L. Mental ill health in adults with intellectual disabilities: prevalence and associated factors. *Br J Psychiatry.* 2007;190:27-35.
13. Gustafsson C, Sonnander K. Occurrence of mental health problems in Swedish samples of adults with intellectual disabilities. *Soc Psychiatry Psychiatr Epidemiol.* 2004;39:448-56.
14. Smith S, Branford D, Cooper SA, McGrother C, Collacott RA. Prevalence and cluster typology of maladaptive behaviors in a geographically defined population of adults with learning disabilities. *Br J Psychiatry.* 1996;169(2):219-27.
15. Statistics Canada. The Canadian Community Health Survey (CCHS) cycle 3.1 (2005): Public use microdata file (PUMF) user guide. Ottawa (ON): Statistics Canada; 2006.
16. Statistics Canada. Participation and Activity Limitation Survey 2006: technical and methodological report. Ottawa (ON): Statistics Canada; 2006. [Statistics Canada, Catalogue No.: 89-628 XIE No. 001].
17. Statistics Canada. Canada Community Health Survey, cycle 3.1 questionnaire [Internet]. Ottawa (ON): Statistics Canada; 2004 [cited 2010 Dec 14]. Available from: http://www.statcan.gc.ca/concepts/health_sante/cycle3_1/pdf/cchs_esc_q3_1_3_eng.pdf
18. Statistics Canada. Participation and Activity Limitation survey questionnaire [Internet]. Ottawa (ON): Statistics Canada; 2006. [cited 2010 Dec 14]. Available from: http://www.statcan.gc.ca/imdb/bmdi/instrument/3251_Q2_V2_eng.pdf
19. Hoetmer S, Patterson P, Shea C, Skinner J. Vegetable and fruit consumption [Internet]. Association of Public Health Epidemiologists in Ontario; 2011 [cited 2011 Nov 4]. Available from: <http://www.apheo.ca/index.php/pid-128>
20. Gallant D. Institution Watch [Internet]. Toronto (ON): Canadian Association for Community Living; 2004 Spring [cited 2011 Nov 4]. Available from: <http://www.institutionwatch.ca/cms/filesystem/action/file-pdf/iw%20march%202004.pdf>
21. Lowe K, Allen D, Jones E, Brophy S, Moore K, James W. Challenging behaviours: prevalence and topographies. *J Intellect Disabil Res.* 2007;51(8):625-36.
22. Lund J. The prevalence of psychiatric morbidity in mentally retarded adults. *Acta Psychiatr Scand.* 1985;72:563-70.
23. Lakin KC, Doljanic R, Taub S, Chiri G, Byun S Y. Adults with dual diagnoses of intellectual and psychiatric disability receiving Medicaid Home and Community Based Services (HCBS) and ICF/MR recipients in six States. *Ment Health Aspects Dev Disabil.* 2007;10(3):78-90.
24. Cooper SA, Bailey NM. Psychiatric disorders amongst adults with learning disabilities - prevalence and relationship to ability level. *Ir J Psychol Med.* 2001;18(2):45-53.
25. Alberta Committee of Citizens with Disabilities. Federal government to discontinue PALS [Internet]. Edmonton (AB): ACCD; 2010 Nov [cited 2010 Dec 14]. Available from: http://www.accd.net/publications/Action_News/2010_November_Action_News.pdf
26. Clark C. Scrapped mandatory census cuts even deeper for disability advocacy group [Internet]. The Globe and Mail (Ottawa Ed.); 2010 Jul 24 [cited 2010 Dec 14]. Available from: <http://m.theglobeandmail.com/news/politics/scrapped-mandatory-census-cuts-even-deeper-for-disability-advocacy-group/article1650753/?service=mobile>
27. Council of Canadians with Disabilities. Canada ratifies United Nations Convention on the Rights of Persons with Disabilities [Internet]. 2010 Mar 11 [cited 2011 Aug 20]. Available from: <http://www.ccdonline.ca/en/international/un/canada/crpd-pressrelease-11March2010>

Cardiovascular disease mortality among First Nations people in Canada, 1991–2001

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Abstract

Objective: To compare cardiovascular disease mortality patterns between First Nations people and non-Aboriginal adults by sex and by income adequacy quintile and level of educational attainment.

Methods: A 15% sample of 1991 Canadian census respondents aged 25 years or older was previously linked to 11 years of mortality data. In this study, First Nations people were defined by North American Indian ethnic origin (ancestry), registration under the *Indian Act*, and/or membership in an Indian band or First Nation. The cohort included 62 400 First Nations people and 2 624 300 non-Aboriginal people.

Results: Compared to non-Aboriginal cohort members, the age-standardized cardiovascular disease mortality rate was 30% higher for First Nations men and 76% higher for First Nations women. This represented an excess of 58 deaths and 71 deaths per 100 000 person-years at risk, for First Nations men and women, respectively. Within each income adequacy quintile (adjusted for family size and region of residence) and level of educational attainment, the risk of dying from cardiovascular disease was higher for First Nations people compared to their non-Aboriginal counterparts.

Conclusion: First Nations people had higher rates of death from cardiovascular disease than non-Aboriginal Canadians within each income quintile and level of education. Income and education accounted for 67% and 25% of the excess mortality of First Nations men and women respectively.

Keywords: *Indigenous, Registered Indian, non-status Indian, Aboriginal, income, education*

Introduction

Indigenous peoples worldwide experience a disproportionate burden of disease and illness.^{1,2} Historically, infectious diseases were largely responsible for the poorer health of Aboriginal people.³ However, since the 1960s the Aboriginal population has undergone an epidemiological transition during which the prevalence of non-communicable diseases such as diabetes and cardiovascular disease has increased while that of infectious diseases has decreased.^{4,5}

Cardiovascular disease is a major cause of premature death, admissions to hospitals and disability,⁶ and it imposes a large burden on the health care system.⁷ Survey data have demonstrated that the prevalence of self-reported heart disease is higher among First Nations people residing on-reserve,⁸ and similar for Aboriginal (including First Nations, Métis and Inuit) people residing off-reserve, compared to the non-Aboriginal population.⁹ However, results based on self-reporting may not reflect the true extent of the disparities between First Nations

people and other Canadians.¹⁰ A more fundamental indicator of disease burden and one which is more reliable for tracking trends over time could be based on mortality rates. In Canada, death registrations usually contain no First Nations identifiers, so either a record linkage or an area-based approach is required. Studies that have linked lists of Registered Indians (First Nations individuals who are registered under the *Indian Act of Canada*) to vital statistics death registrations have shown that Registered Indians had higher rates of cardiovascular disease mortality than other Canadians.^{3,8,11} However, those studies excluded people who self-identify as First Nations but are not registered under the *Indian Act* ("non-Status Indians") and provided no information on whether differences in socio-economic status played a role in explaining the disparities.

An estimated 80% of premature cardiovascular disease can be prevented,⁷ so it should be possible to considerably reduce the burden of cardiovascular disease. A target for 2020 described as "ambitious but achievable" in the Canadian Heart Healthy Strategy and Action Plan¹² is to decrease the burden of cardiovascular diseases among Aboriginal people to the same level as that for other Canadians. To monitor progress towards that goal, it will be necessary to track cardiovascular disease mortality among all Aboriginal peoples, including First Nations, Inuit and Métis. The objective of this study is to assess the burden of cardiovascular disease mortality for First Nations people, including both Status and non-Status Indians, and to compare the rates to those of

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non-Aboriginal adults by sex and by income adequacy quintile and level of educational attainment.

Methods

Data source

This study is a secondary analysis of data from the 1991–2001 Canadian census mortality follow-up study.¹² Individuals were eligible to be in the original study cohort if they were aged 25 years or more and enumerated by the 1991 census long form questionnaire, which excluded institutionalized residents. To be followed for mortality, in-scope census respondents first had to be linked to an encrypted name file abstracted from non-financial tax-filer data. About 80% of in-scope census records ($n = 2\,860\,244$) were linked to the name file. A random sample of respondents ($n = 125\,093$) were then removed so that the final cohort ($n = 2\,735\,152$) would be a 15% sample of the Canadian population, as stipulated in the record linkage protocol. This cohort was then matched to the Canadian mortality database (4 June 1991 to 31 December 2001) using probabilistic record linkage methods primarily based on names and dates of birth.^{14,15} Ascertainment of death was estimated to be slightly lower (95% to 96%) among First Nations cohort members, compared with the cohort as a whole (97%). Additional details of the construction and contents of the previously linked file are reported elsewhere.¹² In our study we compared cardiovascular disease mortality patterns between First Nations people and non-Aboriginal adults by sex and by income adequacy quintile and level of educational attainment.

The Canadian census mortality follow-up study was approved by the Statistics Canada Policy Committee after consultations with the Statistics Canada Confidentiality and Legislation Committee, the Data Access and Control Services Division, and the Federal Privacy Commissioner.

Definitions

For the purposes of this study, we defined First Nations people as census respondents who either reported one ancestry, North American Indian, or indicated

being registered under the *Indian Act*, or indicated being a member of an Indian Band or First Nation. About three-quarters of the First Nations cohort members met all three criteria. About 9% of First Nations cohort members did not indicate being a Registered Indian.

Non-Aboriginal cohort members included anyone except those whose census responses indicated North American Indian, Métis or Inuit ancestry, Registered Indian status or membership in a North American Indian band or First Nation. Cohort members not defined as either First Nations or non-Aboriginal were excluded from this analysis.

A First Nations community (or Indian reserve) refers to land set aside by the Federal Government for the use and occupancy of an Indian group or band.

Level of education was grouped into two categories: less than high school diploma and high school diploma (or trades certificate) or higher.

Quintiles of population by income adequacy were constructed as follows. First, for each economic family or unattached individual, total pre-tax, post-transfer income from all sources was pooled across all family members, and the ratio of total income to the Statistics Canada low-income cut-off for the applicable family size and community size group was calculated.¹⁶ Thus, all members of a given family were assigned the same ratio, which was calculated for all non-institutionalized people (the in-scope population), including people living on Indian reserves. The population was then ranked according to that ratio, and quintiles of population were constructed within each census metropolitan area, census agglomeration or total rural and small town area within a given province or territory. The purpose of constructing the quintiles within each area was to take account of regional differences in housing costs, which were not reflected in the low income cut-offs. For this analysis, quintiles 4 and 5 were grouped due to the small number of First Nations respondents in those categories.

Analytical techniques

For each member of the cohort, we calculated person-days of follow up from the beginning of the study (4 June 1991) to the date of death, the date of emigration (which was only known for 1991), or to the end of study (31 December 2001). For each category of cardiovascular disease, we first calculated age- and sex-specific mortality rates by 5-year age groups (at baseline), and then, using the total Aboriginal cohort population structure (person-years at risk) as the standard population (an internal weighting scheme), we calculated age-standardized mortality rates (ASMRs) for each disease group, by sex and for subgroups of the population. Rate ratios (RRs) and rate differences (RDs) were calculated comparing the ASMRs for First Nations to those of non-Aboriginal cohort members. The rate difference was our measure of excess mortality. We calculated 95% confidence intervals (CIs) for the ASMRs, RRs and RDs based on a Poisson distribution.

Cox proportional hazard ratios for death by cardiovascular disease were calculated for First Nations compared to non-Aboriginal cohort members, by sex, first controlling for age (in years), then controlling for age and education (less than high school diploma versus high school diploma or higher), then controlling for age and income adequacy (quintiles 1, 2 and 3 compared to quintiles 4 and 5 combined). The final, fully adjusted model controlled for age, education and income adequacy (simultaneously). We interpreted differences in the hazard ratios between the age-adjusted model and the fully adjusted model as estimates of the effect of education and income on the extent of disparities between First Nations and non-Aboriginal adults. The proportion of excess mortality explained by differences in education and income was calculated as the difference between the age-adjusted and the fully adjusted hazard ratios, divided by the age-adjusted hazard ratio minus 1.

The cause of death of those who died in the years 1991 to 1999 had been previously coded using the World Health Organization's *International Classification of Diseases, Ninth Revision* (ICD-9) codes, and that of those who died in 2000 or 2001

had been previously coded using the *Tenth Revision* (ICD-10) codes. We grouped the ICD codes as follows: all cardiovascular diseases (ICD-9 390–459; ICD-10 I00–I99), ischemic heart disease (ICD-9 410–414; ICD-10 I20–I25), acute myocardial infarction (ICD-9 410; ICD-10 I21–I22), cerebrovascular disease (ICD-9 430–438; ICD-10 I60–I69), stroke (ICD-9 430, 431, 434, 436; ICD-10 I60, I61, I63, I64), congestive heart failure (ICD-9 428.0; ICD-10 I50.0), inflammatory heart disease (ICD-9 420–422, 425; ICD-10 I30–I33, I38, I40, I42), rheumatic heart disease (ICD-9 390–398; ICD-10 I01–I09), and hypertensive heart disease (ICD-9 401–405; ICD-10 I10–I13).

Results

The cohort follow-up tracked mortality for 27 300 First Nations men, 1 307 800 non-Aboriginal men, 35 100 First Nations women and 1 316 500 non-Aboriginal women. Compared to non-Aboriginal cohort members, First Nations cohort members tended to be younger, with a lower level of formal education, less income and more often lived in western Canada and the north (Table 1).

Cardiovascular disease deaths accounted for 29% and 27% of all deaths among First Nations men and women, respectively. Ischemic heart disease was the most common type of cardiovascular disease mortality (62% of all cardiovascular disease deaths for First Nations men; 45% for First Nations women), followed by cerebrovascular disease (14% for First Nations men; 25% for First Nations women). Compared to non-Aboriginal cohort members, the risk of dying from cardiovascular disease was 30% higher among First Nations men and 76% higher among First Nations women. This translates into an additional 58 deaths per 100 000 person-years at risk for First Nations men and an additional 71 deaths per 100 000 person-years at risk for First Nations women (Table 2).

Compared to non-Aboriginal cohort members, the relative risk of dying was particularly elevated among First Nations men and women for rheumatic heart disease (RR = 3.8 and 2.9, respectively), congestive heart failure (RR = 2.2 and 3.2,

TABLE 1
Selected characteristics of First Nations and non-Aboriginal men and women, non-institutional cohort members aged 25 years or older at baseline, Canada, 1991

	First Nations		Non-Aboriginal	
	Men	Women	Men	Women
Number	27 300	35 100	1 307 800	1 316 500
Percentage	100	100	100	100
Age group (years), %				
25–34	41	44	27	28
35–44	28	28	26	26
45–54	16	15	18	17
55–64	9	8	14	12
65–74	5	4	10	10
75–84	2	2	4	5
85+	< 1	< 1	1	1
Province, region or territory of residence, %				
Atlantic Canada ^a	5	5	8	8
Quebec	12	13	26	26
Ontario	18	17	37	37
Manitoba	18	16	4	4
Saskatchewan	12	13	4	3
Alberta	9	11	9	9
British Columbia	20	19	12	12
Territories ^b	6	5	1	0
Residing in a First Nations community, %				
Yes	67	63	0	0
No	33	37	100	100
Educational attainment, %				
Less than high school graduation	59	55	34	34
High school graduation	33	29	38	35
Post-secondary diploma	7	13	13	19
University degree	2	3	15	12
Income adequacy quintile, %				
Quintile 1 – lowest	38	42	14	19
Quintile 2	26	25	19	19
Quintile 3	18	17	21	20
Quintile 4	12	11	23	20
Quintile 5 – highest	6	6	23	21

Source: 1991–2001 Canadian census mortality follow-up study.

Note: Counts have been rounded to the nearest 100.

^a New Brunswick, Prince Edward Island, Nova Scotia and Newfoundland and Labrador.

^b Yukon, Northwest Territories and Nunavut.

respectively), inflammatory heart disease (RR = 1.7 and 2.3, respectively), stroke (RR = 1.3 and 2.0, respectively) and hypertensive heart disease (RR = 2.1 for First Nations women) (Table 2).

RDs, a measure of absolute burden, indicate that ischemic heart disease accounted for

the majority of excess mortality due to cardiovascular disease (61% of the RD) for First Nations men whereas both ischemic heart disease (36% of the RD) and cerebrovascular disease (29% of the RD) were the largest contributors to such excess mortality for First Nations women (Table 2).

TABLE 2
All cardiovascular disease deaths by sub-type, age-standardized mortality rate per 100 000 person-years at risk, rate ratios and rate differences per 100 000 persons-years at risk for First Nations men and women compared to non-Aboriginal men and women, by age groups, non-institutional cohort members aged 25 years or older at baseline, Canada, 1991–2001

	First Nations				Non-Aboriginal				First Nations compared to non-Aboriginal			
	Deaths	% of all CVD deaths	ASMR	95% CI	Deaths	% CVD deaths	ASMR	95% CI	RR	95% CI	RD	95% CI
Men												
All causes	2 633	—	885.7	852.4, 920.3	149 335	—	566.7	563.4, 569.9	1.56	1.50, 1.62	319.0	284.9, 353.1
All cardiovascular disease	763	100.0	250.2	233.0, 268.6	55 514	100.0	192.5	190.8, 194.3	1.30	1.21, 1.40	57.7	39.8, 75.6
Ischemic heart disease	476	62.4	156.7	143.2, 171.5	34 383	61.9	121.4	120.0, 122.8	1.29	1.18, 1.41	35.3	21.2, 49.5
Acute myocardial infarction	250	32.8	82.2	72.6, 93.1	18 270	32.9	65.9	64.9, 67.0	1.25	1.10, 1.41	16.3	6.0, 26.6
Cerebrovascular disease	109	14.3	35.3	29.3, 42.7	8 638	15.6	28.2	27.5, 28.8	1.25	1.04, 1.52	7.2	0.5, 13.9
Stroke	95	12.5	30.7	25.1, 37.6	7 209	13.0	23.7	23.1, 24.3	1.30	1.06, 1.59	7.1	0.8, 13.3
Other cardiovascular diseases	178	23.3	58.1	50.2, 67.4	12 493	22.5	43.0	42.1, 43.8	1.35	1.17, 1.57	15.2	6.6, 23.8
Congestive heart failure	34	4.5	10.8	7.7, 15.1	1 670	3.0	5.0	4.7, 5.2	2.18	1.55, 3.06	5.8	2.2, 9.5
Inflammatory heart diseases	23	3.0	7.6	5.0, 11.4	1 033	1.9	4.5	4.2, 4.8	1.68	1.11, 2.55	3.1	0.0, 6.2
Rheumatic heart disease	9	1.2	3.1	1.6, 5.9	216	0.4	0.8	0.7, 0.9	3.83	1.96, 7.49	2.3	0.3, 4.3
Hypertensive heart disease	8	1.0	2.5	1.3, 5.1	731	1.3	2.5	2.3, 2.7	1.04	0.52, 2.08	0.1	–1.7, 1.9
Women												
All causes	2 317	—	622.3	597.4, 648.2	103 890	—	318.9	316.5, 321.2	1.95	1.87, 2.03	303.4	277.9, 328.9
All cardiovascular disease	628	100.0	164.9	152.5, 178.4	39 066	100.0	94.0	92.9, 95.1	1.76	1.62, 1.90	71.0	58.0, 84.0
Ischemic heart disease	280	44.6	73.5	65.3, 82.6	20 098	51.4	48.1	47.3, 48.8	1.53	1.36, 1.72	25.4	16.7, 34.1
Acute myocardial infarction	147	23.4	38.8	33.0, 45.6	10 009	25.6	25.1	24.6, 25.7	1.54	1.31, 1.82	13.6	7.3, 19.9
Cerebrovascular disease	157	25.0	41.7	35.6, 48.7	8 835	22.6	21.4	20.9, 21.9	1.95	1.66, 2.28	20.3	13.7, 26.8
Stroke	139	22.1	37.0	31.3, 43.7	7 611	19.5	18.7	18.2, 19.2	1.98	1.67, 2.34	18.3	12.1, 24.4
Other cardiovascular diseases	81	12.9	49.8	43.2, 57.4	10 133	25.9	24.5	23.9, 25.1	2.03	1.76, 2.35	25.3	18.2, 32.4
Congestive heart failure	41	6.5	10.3	7.6, 14.0	1 714	4.4	3.2	3.0, 3.4	3.23	2.36, 4.40	7.1	3.9, 10.3
Inflammatory heart diseases	13	2.1	3.5	2.1, 6.1	439	1.1	1.6	1.4, 1.7	2.27	1.30, 3.96	2.0	0.0, 3.9
Rheumatic heart disease	12	1.9	3.2	1.8, 5.7	389	1.0	1.1	1.0, 1.3	2.88	1.62, 5.14	2.1	0.3, 4.0
Hypertensive heart disease	15	2.4	4.0	2.4, 6.7	862	2.2	1.9	1.8, 2.1	2.07	1.24, 3.46	2.1	0.0, 4.1

Source: 1991 to 2001 Canadian census mortality follow-up study.

Abbreviations: ASMR, age-standardized mortality rate; CI, confidence interval; CVD, cardiovascular disease; RD, rate difference; RR, rate ratio.

Note: Reference population (person-years at risk) for age standardization was taken from the Aboriginal age distribution (5-year age groups).

ASMRs for cardiovascular disease mortality were highest for First Nations people residing in the Atlantic region (New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador) and Manitoba, and lowest for those residing in Quebec and the territories (Yukon, Northwest Territories, Nunavut) (Table 3). The ASMRs for cardiovascular disease were similar among First Nations people regardless of residence on- or off-reserve (Table 3).

The relative risk of dying from cardiovascular disease (compared to non-Aboriginal cohort members) was highest in the younger age

groups and diminished with age (Figure 1). For First Nations people aged 25 to 34 years at baseline, the risk of dying from cardiovascular disease was 62% higher for men and 217% higher for women compared to their non-Aboriginal counterparts. By contrast the relative risk of dying from cardiovascular disease was slightly lower for First Nations men aged 75 years or older and similar for First Nations women aged 85 years or older.

For both First Nations and non-Aboriginal cohort members, ASMRs for cardiovascular disease were higher for those with less than a high school diploma compared to

those with a high school diploma or higher (Table 4). Higher relative risks (First Nations compared to non-Aboriginal) were evident within both levels of education for both sexes. For First Nations compared to non-Aboriginal men, relatively higher RRs and RDs were observed for those with a high school diploma or higher. For First Nations compared to non-Aboriginal women, RRs and RDs were similarly elevated regardless of level of educational attainment (Table 4).

By income adequacy quintile, cardiovascular disease mortality rates showed a stair-stepped gradient (with the lowest

TABLE 3
All cardiovascular disease deaths, age-standardized mortality rates per 100 000 person-years at risk, rate ratios and rate differences per 100 000 person-years at risk comparing First Nations men and women to non-Aboriginal men and women, by selected geographic areas, non-institutional cohort members age 25 years or older at baseline, Canada, 1991–2001

Residence in June 1991	First Nations			Non-Aboriginal			First Nations compared to non-Aboriginal			
	Deaths	ASMR	95% CI	Deaths	ASMR	95% CI	RR	95% CI	RD	95% CI
Men										
Canada	763	250.2	233.0, 268.6	55 514	192.5	190.8, 194.3	1.30	1.21, 1.40	57.7	39.8, 75.6
Atlantic Canada ^a	39	396.4	270.0, 581.8	4 956	214.1	207.7, 220.7	1.85	1.26, 2.72	182.3	30.0, 334.5
Quebec	57	164.4	126.5, 213.5	13 527	200.0	196.4, 203.6	0.82	0.63, 1.07	-35.6	-78.8, 7.6
Ontario	146	264.8	224.9, 311.8	20 854	192.5	189.6, 195.4	1.38	1.17, 1.62	72.3	29.0, 115.7
Manitoba	195	337.1	292.5, 388.4	2 681	201.6	193.1, 210.6	1.67	1.44, 1.94	135.4	86.8, 184.0
Saskatchewan	87	252.1	204.1, 311.5	2 437	188.2	179.6, 197.3	1.34	1.08, 1.66	63.9	9.9, 117.9
Alberta	67	277.9	217.2, 355.7	4 090	181.7	175.9, 187.7	1.53	1.19, 1.96	96.2	27.4, 165.1
British Columbia	152	233.2	198.7, 273.6	6 877	169.4	165.0, 173.9	1.38	1.17, 1.62	63.8	26.2, 101.3
Territories ^b	20	98.8	63.3, 154.2	92	167.8	133.0, 211.7	0.59	0.36, 0.97	-69.0	-127.9, -10.2
Residing in a First Nations community										
Yes	550	257.6	236.9, 280.2	—	—	—	1.34	1.23, 1.46	65.2	43.4, 86.9
No	213	232.9	203.4, 266.6	55 393	192.5	190.7, 194.2	1.21	1.06, 1.39	40.4	8.9, 71.9
Women										
Canada	628	164.9	152.5, 178.4	39 066	94.0	92.9, 95.1	1.76	1.62, 1.90	71.0	58.0, 84.0
Atlantic Canada	36	244.5	174.0, 343.6	3 521	108.8	104.6, 113.2	2.25	1.60, 3.16	135.7	52.4, 219.0
Quebec	57	117.4	90.4, 152.4	9 064	83.7	81.7, 85.8	1.40	1.08, 1.82	33.6	2.9, 64.4
Ontario	121	182.6	152.7, 218.5	15 100	98.6	96.8, 100.4	1.85	1.55, 2.22	84.1	51.3, 116.8
Manitoba	132	212.7	178.9, 252.8	2 073	102.4	96.9, 108.3	2.08	1.73, 2.49	110.2	73.1, 147.4
Saskatchewan	71	143.6	113.7, 181.4	1 619	94.0	88.3, 100.1	1.53	1.20, 1.95	49.6	15.5, 83.7
Alberta	57	141.3	108.9, 183.4	2 762	94.7	90.9, 98.7	1.49	1.15, 1.94	46.6	9.6, 83.7
British Columbia	138	183.7	155.0, 217.8	4 905	90.4	87.5, 93.4	2.03	1.71, 2.42	93.3	61.9, 124.7
Territories ^b	16	73.7	43.6, 124.8	22	147.2	48.1, 450.6	0.50	0.15, 1.72	-73.5	-242.6, 95.7
Residing in a First Nations community										
Yes	424	167.3	152.0, 184.2	—	—	—	1.78	1.62, 1.96	73.4	57.3, 89.5
No	204	162.9	142.0, 186.9	39 013	93.9	92.8, 95.0	1.73	1.51, 1.99	69.0	46.5, 91.4

Source: 1991 to 2001 Canadian census mortality follow-up study.

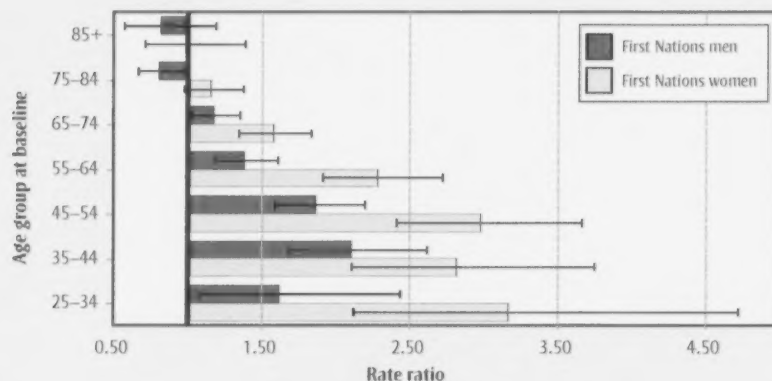
Abbreviations: ASMR, age-standardized mortality rate; CI, confidence interval; CVD, cardiovascular disease; RD, rate difference; RR, rate ratio.

Note: Reference population (person-years at risk) for age standardization was taken from the Aboriginal age distribution (5-year age groups).

^a New Brunswick, Prince Edward Island, Nova Scotia and Newfoundland and Labrador.

^b Yukon, Northwest Territories and Nunavut.

FIGURE 1
Cardiovascular disease mortality rate ratios comparing First Nations to non-Aboriginal cohort members



income quintile having the highest mortality) for both First Nations and non-Aboriginal cohort members (Table 4). The mortality gradient was steeper for non-Aboriginal cohort members than for First Nations cohort members. Higher relative risks (First Nations compared to non-Aboriginal) were evident within each income strata, with the highest ratios in the highest income quintile (RR = 1.29 for First Nations men; RR = 1.91 for First Nations women).

After adjusting for educational attainment and income adequacy, the risk of dying from cardiovascular disease was 8% higher for First Nations men and 50% higher for First Nations women (compared to non-Aboriginal cohort members)

(Table 5). Compared to the age-adjusted hazard ratios, the relative risk of dying from cardiovascular disease (after adjusting for education and income) was reduced by 67% (from 1.24 to 1.08) for First Nations men and by 25% for First Nations women (from 1.67 to 1.50).

Discussion

This study was the first to estimate cardiovascular disease mortality rates for First Nations people by level of educational attainment and income adequacy in Canada. Our results show that First Nations adults were at higher risk of

dying from cardiovascular disease compared to non-Aboriginal adults, both overall and within subgroups classified by education and income. This study included First Nations people who were not registered under the *Indian Act* (non-Status Indians), and included data from all provinces and territories of Canada.

The burden of cardiovascular disease has increased among Aboriginal peoples in Canada over the past several decades.^{5,7,17} However, results from British Columbia indicate that ASMRs for cardiovascular disease among Status Indians decreased

between 1993 and 2006, but the rate remained 25% higher compared to that of other residents of British Columbia.¹²

Research has demonstrated that the prevalence of traditional cardiovascular disease risk factors is more common among First Nations than among non-Aboriginal people. These include higher rates of smoking,^{8,9,18,19} high blood pressure,^{8,20} obesity,^{8,20} diabetes,^{21,22} and poor diet.^{22,24}

In addition to those well-known cardiovascular disease risk factors, it has been argued that social factors such as education and income are fundamental determinants

TABLE 4
All cardiovascular disease deaths, age-standardized mortality rates per 100 000 person-years at risk, rate ratios and rate differences per 100 000 person-years at risk comparing First Nations men and women to non-Aboriginal men and women, by selected socio-economic indicators, non-institutional cohort members aged 25 years or older at baseline, Canada, 1991–2001

Characteristic measured in 1991	First Nations			Non-Aboriginal			First Nations compared to non-Aboriginal			
	Deaths	ASMR	95% CI	Deaths	ASMR	95% CI	RR	95% CI	RD	95% CI
Educational attainment										
Men										
Less than high school diploma	606	256.7	236.3, 278.8	33 776	227.8	224.5, 231.1	1.13	1.04, 1.23	28.9	7.4, 50.4
High school diploma or higher	157	231.4	190.6, 281.0	21 738	166.4	164.2, 168.7	1.39	1.14, 1.69	65.0	20.0, 110.0
Women										
Less than high school diploma	530	176.3	161.3, 192.6	25 307	110.6	108.6, 112.7	1.59	1.46, 1.74	65.7	49.9, 81.4
High school diploma or higher	98	141.8	108.5, 185.4	13 759	79.7	78.3, 81.1	1.78	1.36, 2.33	62.1	24.1, 100.2
Income adequacy quintile										
Men										
Quintile 1 – lowest	309	298.4	266.4, 334.3	13 053	273.1	267.3, 279.1	1.09	0.97, 1.23	25.3	–9.1, 59.7
Quintile 2	239	257.3	225.0, 294.4	15 476	213.4	209.1, 217.8	1.21	1.05, 1.38	44.0	9.1, 78.9
Quintile 3	116	222.4	185.2, 267.2	10 088	185.0	181.2, 189.0	1.20	1.00, 1.45	37.4	–3.5, 78.3
Quintiles 4,5 – highest	99	208.0	169.0, 256.0	16 897	161.1	158.6, 163.6	1.29	1.05, 1.59	46.9	3.7, 90.2
Women										
Quintile 1 – lowest	275	185.5	164.7, 209.0	15 918	127.7	124.5, 131.0	1.45	1.29, 1.64	57.8	35.5, 80.2
Quintile 2	211	172.6	149.8, 198.8	9 346	98.6	96.0, 101.3	1.75	1.51, 2.02	74.0	49.4, 98.6
Quintile 3	81	142.2	113.6, 178.1	5 559	88.9	86.4, 91.5	1.60	1.28, 2.01	53.3	21.2, 85.4
Quintiles 4,5 – highest	61	146.7	112.1, 192.0	8 243	76.7	75.1, 78.5	1.91	1.46, 2.50	70.0	30.5, 109.4

Source: 1991 to 2001 Canadian census mortality follow-up study.

Abbreviations: ASMR, age-standardized mortality rate; CI, confidence interval; CVD, cardiovascular disease; RD, rate difference; RR, rate ratio.

Note: Note: Reference population (person-years at risk) for age standardization was taken from the Aboriginal age distribution (5-year age groups).

TABLE 5
Hazard ratios for dying from cardiovascular disease for First Nations compared to non-Aboriginal cohort members, controlling for selected socio-economic indicators, non-institutionalized persons aged 25 years or older at baseline, Canada, 1991–2001

Adjusted for:	Men		Women	
	Hazard ratio	95% CI	Hazard ratio	95% CI
Age	1.24	1.16, 1.34	1.67	1.54, 1.80
Age + education	1.15	1.07, 1.24	1.55	1.44, 1.68
Age + income adequacy	1.13	1.05, 1.21	1.58	1.46, 1.71
Age + education + income adequacy	1.08	1.00, 1.16	1.50	1.39, 1.63

Source: 1991 to 2001 Canadian census mortality follow-up study.

Abbreviation: CI, confidence interval.

Note: Models controlled for age in years (continuous), education (high school diploma or higher versus less than high school diploma) and income adequacy quintiles (1, 2, or 3 versus 4 + 5 combined).

of illness and disease.²⁵ First Nations people have lower levels of educational attainment and income compared to other Canadians.^{8,26} We examined the relationship of education and income adequacy to inequalities in cardiovascular disease mortality comparing First Nations and non-Aboriginal cohort members. Differences remained when mortality rates were calculated within each level of educational attainment and income adequacy, indicating that these factors alone do not explain the disparity. In Cox models that controlled for income and education simultaneously, hazard ratios were attenuated by 67% for men and 25% for women, suggesting that these factors are important in explaining some but not all of the disparity. Research that examined the impact of socio-economic status on inequalities in self-rated health and chronic conditions—comparing First Nations people living off-reserve and other Canadians—demonstrated that factors such as income and education minimize but do not eliminate those health disparities.²⁷ This research also showed that factors often associated with health in the general population do not always act in the same way for First Nations people.²⁷ For example, among non-Aboriginal adults, men were less likely than women to report being in excellent or very good health whereas among First Nations adults, men and women were equally likely to report being in excellent or very good health. Although our results showed that cardiovascular disease mortality was higher among men than women for both First Nations and non-Aboriginal cohort members, the rate difference between men and women was smaller for First Nations than for non-Aboriginal cohort members. Thus, in terms of sex differences in cardiovascular disease mortality, First Nations women appeared to have less of an advantage compared to non-Aboriginal women. Determining why that is true would require additional study.

Limitations

Our data excluded people who were not enumerated by the 1991 census long-form questionnaire, that is, people residing in long-term care facilities, seniors' residences or prisons, as well as people not enumerated by the census (about 3.4% of Canadian residents of all ages). The missed individuals

were more likely to be young, mobile, living in low income, of Aboriginal ancestry,²⁸ homeless and residents of Indian reserves.²⁹ In addition, since it was necessary to obtain encrypted names from tax filer data, only tax filers could be followed for mortality. Linkage rates to the name file abstracted from tax filer data were lower for First Nations (54%) compared with non-Aboriginal census respondents (77%). However, the socio-economic profile of First Nations cohort members was similar to that of all First Nations long-form census respondents, suggesting that there was little bias in the first linkage (data not shown).

This study defined First Nations people by ancestry, Registration under the *Indian Act*, or membership in an Indian band or First Nation, because questions on self-perceived Aboriginal identity were not included in the 1991 census. Our definition of First Nations excluded many people of mixed Aboriginal and non-Aboriginal origin whose census characteristics (data not shown) were closer to those of non-Aboriginal people than to First Nations people as defined for this study.

Our study examined cardiovascular disease mortality and not morbidity. Since mortality is the final outcome of a disease progression, the full burden of cardiovascular disease was not assessed.

Place of residence, education level and income were measured only at baseline (4 June 1991) and do not necessarily reflect the situation later in the follow-up period.

Conclusion

The higher burden of cardiovascular disease among Aboriginal peoples is increasingly recognized in Canada.^{4,7} Our results show that cardiovascular disease mortality was higher for First Nations people overall and by level of education and income adequacy. Since up to 80% of premature cardiovascular disease is said to be preventable, it may be possible to substantially reduce the burden of cardiovascular disease among Aboriginal peoples in Canada.⁷ Results from this study show that both income adequacy

and educational attainment were important factors that help to explain the differences in cardiovascular disease mortality rates between First Nations people and non-Aboriginal Canadians.

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References

1. Gracey M, King M. Indigenous health part 1: determinants and disease patterns. *Lancet*. 2009; 374(9683):65-75.
2. Canadian Population Health Initiative. Improving the health of Canadians. Ottawa (ON): Canadian Institute of Health Information; 2004.
3. Waldram JB, Herring DA, Young TK. Aboriginal health in Canada: historical, cultural, and epidemiological perspectives, 2nd ed. Toronto (ON): University of Toronto Press; 2006.
4. Reading J. The crisis of chronic disease among Aboriginal peoples: a challenge for public health, population health and social policy. Victoria (BC): Centre for Aboriginal Health Research, University of Victoria; 2009.
5. Trovato F. Canadian Indian mortality during the 1980s. *Soc Biol*. 2000; 47(1-2):135-45.
6. Lee DS, Chiu M, Manuel DG, Tu K, Wang X, Austin PC, et al. Trends in risk factors for cardiovascular disease in Canada: temporal, socio-demographic and geographic factors. *CMAJ*. 2009;181(3-4):E55-E66.

7. CHHS AP Steering Committee. Canadian Heart Health Strategy and Action Plan: building a heart healthy Canada. Ottawa (ON): Canadian Heart Health Strategy and Action Plan; 2009 [accessed 2010 Feb 3]. Available from: <http://www.chhs.ca/sites/default/files/Document%20Links/Reports/English/CHHS%20%20Building%20a%20Heart%20Healthy%20Canada%20%20EN%20%20Feb%202009.pdf>
8. RHS National Team. First Nations regional longitudinal health survey (RHS) 2002/03: results for adults, youth and children living in First Nations communities [Internet]. 2nd rev. ed. Ottawa (ON): Assembly of First Nations/First Nations Information Governance Committee; March 2007 [accessed 2010 Feb 3]. Available from: www.rhs-ers.ca/sites/default/files/ENpdf/rhs2002_03reports/rhs2002_03technicalreport.afn.pdf
9. Lix LM, Bruce S, Sarkar J, Young TK. Risk factors and chronic conditions among Aboriginal and non Aboriginal populations. *Health Rep.* 2009; 20(4): 21-29.
10. Anand SS, Yusuf S, Jacobs R, Davis AD, Yi Q, Gerstein H, et al. Risk factors, atherosclerosis, and cardiovascular disease among Aboriginal people in Canada: the Study of Health Assessment and Risk Evaluation in Aboriginal Peoples (SHARE AP). *Lancet.* 2001; 358(9281): 5147-53.
11. Mao Y, Moloughney BW, Semenciw RM, Morrison HI. Indian reserve and registered Indian mortality in Canada. *Can J Public Health.* 1992; 83(5): 350-3.
12. British Columbia Provincial Health Officer. Pathways to health and healing: 2nd report on the health and well being of Aboriginal people in British Columbia. Provincial Health Officer's Annual Report 2007. Victoria (BC): Ministry of Healthy Living and Sport; 2009.
13. Wilkins R, Tjepkema M, Mustard C, Choinière R. The Canadian census mortality follow up study, 1991 through 2001. *Health Rep.* 2008; 19(3): 25-43.
14. Fair ME. Generalized record linkage system: Statistics Canada's record linkage software. *Austrian J Stat.* 2004; 33(1&2): 37-53.
15. Fair ME, Carpenter M, Aylwin H. Occupational and environmental health research projects: a descriptive catalogue 1978 to 2005. Ottawa (ON): Statistics Canada; 2006 [Statistics Canada, Catalogue No.: 82-581-XIE].
16. Statistics Canada. 1991 census dictionary. Ottawa (ON): Supply and Services Canada; 1992 [Statistics Canada, Catalogue No.: 92-301E].
17. Shah BR, Hux JE, Zinman B. Increasing rates of ischemic heart disease in the native population of Ontario, Canada. *Arch Intern Med.* 2000; 160(12): 1862-6.
18. Anand SS, Razak F, Davis AD, Jacobs R, Vuksan V, Teo K, et al. Social disadvantage and cardiovascular disease: development of an index and analysis of age, sex, and ethnicity effects. *Int J Epidemiol.* 2006; 35(5): 1239-45.
19. Retnakaran R, Hanley AJ, Connelly PW, Harris SB, Zinman B. Cigarette smoking and cardiovascular risk factors among Aboriginal Canadian youths. *CMAJ.* 2005; 173(8): 885-9.
20. Katzmarzyk P. Obesity and physical activity among Aboriginal Canadians. *Obesity.* 2008; 16(1): 184-90.
21. Johnson JA, Vermeulen SU, Toth EL, Hemmelgarn BR, Ralph Campbell K, Hugel G, et al. Increasing incidence and prevalence of diabetes among the Status Aboriginal population in urban and rural Alberta, 1995-2006. *Can J Public Health.* 2009; 100(3): 231-6.
22. Dyck R, Osgood N, Lin TH, Hsiang T, Gao A, Stang MR. Epidemiology of diabetes mellitus among First Nations and non First Nations adults. *CMAJ.* 2010; 182(3): 249-56.
23. Dewailly E, Blanchet C, Gingras S, Lemieux S, Holub BJ. Cardiovascular disease risk factors and n-3 fatty acid status in the adult population of James Bay Cree. *Am J Clin Nutr.* 2002; 76(1): 85-92.
24. Garriguet D. Obesity and the eating habits of the Aboriginal population. *Health Rep.* 2008; 19(1): 21-35.
25. Link BG, Phelan J. Social conditions as fundamental causes of disease. *J Health Soc Behav.* 1995; 35: 80-94.
26. Statistics Canada. Aboriginal Peoples in Canada in 2006: Inuit, Métis and First Nations, 2006 Census. Ottawa (ON): Statistics Canada; 2008 [Statistics Canada, Catalogue No.: 97-558-XIE].
27. Garner R, Carrière G, Sanmartin C, Longitudinal Health and Administrative Data Research Team. The health of First Nations living off reserve, Inuit, and Métis adults in Canada: the impact of socioeconomic status on inequalities of health. Health Research Working Paper Series, No.4. Ottawa (ON): Statistics Canada; 2010 [Statistics Canada, Catalogue No.: 82-622-X004].
28. Statistics Canada. Coverage, Census Technical Reports series. Ottawa (ON): Minister of Industry, Science and Technology; 1994 [Statistics Canada, Catalogue No.: 92-341].
29. Statistics Canada. The 1991 Aboriginal peoples survey microdata file: user's guide. Ottawa (ON): Statistics Canada; 1995.

Income disparities in life expectancy in the City of Toronto and Region of Peel, Ontario

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Abstract

Introduction: To understand the lack of a gradient in mortality by neighbourhood income in a previous study, we used individual-level data from the 1991–2001 Canadian census mortality follow-up study to examine income-related disparities in life expectancy and probability of survival to age 75 years in the City of Toronto and Region of Peel.

Methods: We calculated period life tables for each sex and income adequacy quintile, overall and separately for immigrants and non-immigrants.

Results: For all cohort members of both sexes, including both immigrants and non-immigrants, there was a clear gradient across the income quintiles, with higher life expectancy in each successively richer quintile. However, the disparities by income were much greater when the analysis was restricted to non-immigrants. The lesser gradient for immigrants appeared to reflect the higher proportion of recent immigrants in the lower income quintiles.

Conclusion: These findings highlight the importance of using individual-level ascertainment of income whenever possible, and of including immigrant status and period of immigration in assessments of health outcomes, especially for areas with a high proportion of immigrants.

Keywords: cohort study, mortality, probability of survival, healthy immigrant effect, Canada

Introduction

The “income gradient in health,” where health improves with each incremental increase in income, has been repeatedly demonstrated in both Canada and the United States, in studies of a variety of health outcomes including mortality,^{1,2} life expectancy,³ health-related quality of life³ and disability.^{3,4} Those in a lower socio-economic position experience poorer health outcomes than their more affluent counterparts across a whole spectrum of measures. The socio-economic gradient

is not static; it varies over time, by age and sex, as well as by the health measure and population subgroup studied.

In a recent small-area analysis that examined the relationship between life expectancy and neighbourhood income in the Region of Peel (immediately west of the City of Toronto), we used mortality data from the Ontario vital statistics mortality database for the year 2005, and 2006 census data on the census tract proportion of population with low income

(Appendix Table A). Our results showed that for both men and women, life expectancy was similar across all neighbourhood income quintiles—the expected gradient was clearly not present. We therefore undertook an analysis of previously linked census-mortality cohort data⁵ to help us understand how and why this was happening. We speculated that the high proportion of immigrants (49%) who live in the region may have masked an income gradient in mortality due to the “healthy immigrant” effect. Moreover, because of the mixing of rich and poor in many neighbourhoods, neighbourhood averages misclassify many individuals, thus attenuating effect estimates. Studies in Canada and the United States have shown that the income gradient in mortality is more pronounced when data are analyzed by family income rather than by various measures of neighbourhood income.^{3,6} Previous studies of mortality among immigrants in Canada have either not dealt with differences across income groups^{7–11} or only adjusted for income or neighbourhood income (rather than explicitly showing results by income level).^{12–15}

Our objectives were to report differences in all-cause mortality across income quintiles, using individual and family income derived from census microdata, and to examine how those differences varied among immigrants compared to non-immigrants. Using data from the 1991–2001 Canadian census mortality follow-up study, we calculated period life tables by sex for the combined area of the City of Toronto and Region of

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Peel, by income adequacy quintile, for all cohort members as well as for immigrants and non-immigrants separately. Canadian data on all-cause mortality by individual or family income comparing results for immigrants and non-immigrants have not previously been published, and we hoped that the results would help us to better understand the findings of our previous study in this area.

Methods

Data source

The 1991–2001 Canadian census mortality follow-up study, conducted by Statistics Canada, is a probabilistically linked cohort database where a 15% sample ($n = 2\,735\,152$) of the non-institutional population aged 25 years or older who were enumerated by the 1991 census long-form questionnaire (the cohort) was linked to nearly 11 years of death records (from 4 June 1991 to 31 December 2001) from the Canadian mortality database. This linked file contains information on various demographic characteristics, socio-economic position, activity limitations, and cause and date of any death. Additional details on the construction and contents of the linked file have previously been reported.⁵

For this study, data were extracted for the 1991 census divisions corresponding to the current Region of Peel (Mississauga, Brampton and Caledon) and the amalgamated City of Toronto (including the former cities of Toronto, North York, York, Etobicoke and Scarborough, and the former borough of East York). We combined the two areas to obtain sufficient sample size to construct life tables for the 20 sub-populations, each requiring death data by 5-year age group. Both areas have about the same percentage of immigrants, and both are in the same labour market area (the census metropolitan area of Toronto).

Definitions

Income adequacy quintiles. To construct income adequacy quintiles (fifths of the population), a previous study⁵ determined the total pre-tax, post-transfer income from

all sources for each economic family or unattached individual in the entire non-institutional census population. Then, for each family size and community size group, it calculated the ratio of total income to the 1991 low income cut-off. Within each census metropolitan area, census agglomeration and rural areas of each province, the population of all ages, both sexes together, was then ranked according to this ratio and divided into fifths.

Immigrant. In this analysis, the term “immigrant” refers to people who were not Canadian citizens by birth. It includes all persons who were or had ever been landed immigrants in Canada or who had the status of non-permanent residents as reported in the 1991 census. Some immigrants had resided in Canada for a number of years, while others had only arrived recently; virtually all were born outside of Canada.

Non-immigrant. In this analysis, “non-immigrant” refers to people who were Canadian citizens by birth. Almost all non-immigrants were born in Canada.

Analytical techniques

Mortality analyses. For each member of the cohort, person-days of follow-up were calculated from the beginning of the study (4 June 1991) to the date of death, emigration (known for 1991 only) or end of the study (31 December 2001). Person-days of follow-up were then divided by 365.25 to get person-years at risk.

Abridged period life tables for each sex and quintile, plus corresponding standard errors and 95% confidence intervals (CIs) were calculated according to Chiang’s method.¹⁶ These calculations were done after age was transformed from age at baseline to age at the beginning of each year of follow-up, and deaths and person-years at risk were calculated separately for each year (or partial year) of follow-up. Deaths and person-years at risk were then pooled by 5-year age groups at the beginning of each year of follow-up, before the calculation of the life tables.⁵

Results

Cohort members and deaths during the follow-up period

At cohort inception a total of 287 500 cohort members lived in either the City of Toronto (220 400) or Region of Peel (67 100), of whom 53% were immigrants. Of those eligible cohort members, 25 648 died during the follow-up period (12 134 immigrants, 13 514 non-immigrants).

For all cohort members, as well as for immigrants and non-immigrants of each sex, Table 1 shows the number of cohort members in each income quintile, together with the corresponding person-years at risk and number of deaths. Mainly because cohort members had to be linked to tax filer data in order to be followed for mortality, and people of higher income were more likely to be tax filers, fewer than 20% of the cohort were in the lowest income quintile, and more than 20% were in the highest.

Socio-economic characteristics of each income quintile

For all cohort members, immigrants and non-immigrants of both sexes combined, Table 2 shows various socio-economic characteristics for each income adequacy quintile at baseline, expressed as a percentage of the total number of cohort members in each quintile. Since all the characteristics shown were clearly graded by income, we only note the highest and lowest values in each series.

Compared to cohort members in the highest income quintile, those in the lowest income quintile were much more likely to have not graduated from high school (46% versus 16%) and to have government transfers as their major source of income (41% versus 2%); further, they were less likely to have received a university degree (10% versus 39%).

Nearly 100% of immigrants, but fewer than 1% of non-immigrants, were foreign-born. The proportion of foreign-born ranged from 38% in the highest income quintile to 66% in the lowest income quintile. The

TABLE 1
Cohort members, person-years at risk, and deaths during the study period, by income adequacy quintile and sex, by immigrant status, City of Toronto and Region of Peel, 1991–2001 (non-institutionalized people aged 25 and over at baseline)

Immigrant status Income quintile	Men			Women		
	Cohort members	Person-years at risk	Deaths	Cohort members	Person-years at risk	Deaths
Immigrants* and non-immigrants						
Total, all income quintiles	139 700	1 402 110	14 451	147 800	1 508 140	11 197
Quintile 1 (lowest)	24 000	232 550	3 873	31 000	307 590	4 125
Quintile 2	28 700	285 830	3 286	31 300	319 980	2 314
Quintile 3	29 100	294 830	2 623	29 800	306 080	1 779
Quintile 4	29 300	298 240	2 371	28 700	295 790	1 503
Quintile 5 (highest)	28 600	290 690	2 298	27 000	278 760	1 476
Immigrants*						
Total, all income quintiles	75 100	756 830	7 212	76 100	780 790	4 922
Quintile 1 (lowest)	16 400	162 030	2 140	19 600	197 530	1 885
Quintile 2	17 900	180 080	1 766	18 300	188 510	1 066
Quintile 3	16 000	162 780	1 319	15 400	158 530	788
Quintile 4	13 800	140 430	1 108	13 000	134 110	656
Quintile 5 (highest)	11 000	111 540	879	9 900	102 120	527
Non-immigrants						
Total, all income quintiles	64 600	645 270	7 239	71 700	727 360	6 275
Quintile 1 (lowest)	7 600	70 510	1 733	11 400	110 040	2 240
Quintile 2	10 800	105 760	1 520	13 000	131 450	1 248
Quintile 3	13 100	132 020	1 304	14 400	147 560	991
Quintile 4	15 600	157 840	1 263	15 700	161 680	847
Quintile 5 (highest)	17 600	179 150	1 419	17 100	176 600	949

Source: Special tabulations from the 1991–2001 Canadian census mortality follow-up study.^a

Note: The number of cohort members and person years at risk were rounded independently (to the nearest 100, or the nearest 10, respectively).

* Foreign born, including non permanent residents.

TABLE 2
Characteristics of cohort members (immigrants and non-immigrants combined) within each income adequacy quintile, City of Toronto and Region of Peel, at cohort inception, 1991

Income quintile	Total	Foreign born ^a	Percentage of quintile total, %					Aboriginal ^e
			Recent immigrants ^b	Visible minorities ^c	Less than high school graduation	University degree	Government transfers ^d	
Total, all quintiles	100.0	52.8	10.7	24.0	31.2	19.8	14.5	0.8
Quintile 1 (lowest)	100.0	65.7	23.0	35.2	46.4	10.4	41.0	1.0
Quintile 2	100.0	60.5	14.1	29.5	37.5	12.2	15.9	0.8
Quintile 3	100.0	53.5	8.7	24.0	31.1	16.1	8.7	0.8
Quintile 4	100.0	46.4	5.1	18.4	25.1	22.1	5.3	0.7
Quintile 5 (highest)	100.0	37.9	2.8	12.8	16.0	38.8	2.4	0.6

Source: Special tabulations from the 1991–2001 Canadian census mortality follow-up study.^a

^a Almost 100% of immigrants, but less than 1% of non-immigrants, were foreign born.

^b Immigrants in the period 1986–1991.

^c In Canada, the term “visible minorities” does not include Aboriginal peoples; 43% of immigrants and 3% of non-immigrants were visible minorities.

^d Percentage of cohort members whose major source of income was from government transfer payments.

^e Aboriginal ancestry or Registered Indian; almost all (96%) were non-immigrants.

proportion of recent immigrants (1986–1991) ranged from 3% in the highest income quintile to 23% in the lowest.

In Canada, the term “visible minorities” does not include Aboriginal peoples.⁵ In our Toronto-Peel cohort, the proportion

of visible minorities ranged from 13% in the highest income quintile to 35% in the lowest. Almost all Aboriginal cohort members (96%) were non-immigrants, but the proportion of Aboriginal people was low ($\leq 1\%$) in all quintiles.

Table 3 shows the overall percentages of each characteristic for immigrants and non-immigrants separately, plus the percentages for immigrant and non-immigrants within each income quintile. Overall, one-fifth (20%) of immigrants were recent immigrants (1986–1991), but that

TABLE 3
Characteristics of cohort members, showing immigrants and non-immigrants separately within each income adequacy quintile, City of Toronto and Region of Peel, at cohort inception, 1991 (percentage of row total for immigrants and non-immigrants)

Income quintile	Recent immigrants ^a		Visible minorities ^b		Less than high school graduation		University degree		Government transfers ^c		Aboriginal ^d	
	Immigrant	Non-immigrant	Immigrant	Non-immigrant	Immigrant	Non-immigrant	Immigrant	Non-immigrant	Immigrant	Non-immigrant	Immigrant	Non-immigrant
Total, all quintiles	20.3	0.0	43.1	2.8	36.4	25.5	16.3	23.7	16.1	12.6	0.1	1.6
Quintile 1 (lowest)	35.2	0.0	52.1	3.3	45.7	47.7	10.8	9.8	36.6	49.2	0.0	2.7
Quintile 2	23.3	0.0	47.1	2.8	40.5	32.9	11.8	13.0	15.5	16.4	0.0	1.9
Quintile 3	16.4	0.0	42.7	2.6	35.7	25.8	14.5	17.9	9.7	7.6	0.1	1.6
Quintile 4	11.0	0.0	36.5	2.8	30.7	20.2	19.2	24.6	6.8	3.9	0.1	1.3
Quintile 5 (highest)	7.6	0.0	29.7	2.6	21.6	12.6	33.0	42.4	3.5	1.7	0.1	0.9

Source: Special tabulations from the 1991–2001 Canadian census mortality follow-up study.⁴

^a Immigrants in the period 1986–1991.

^b In Canada, the term “visible minorities” does not include Aboriginal people; 43% of immigrants and 3% of non-immigrants were visible minorities.

^c Percentage of cohort members whose major source of income was from government transfer payments.

^d Aboriginal ancestry or Registered Indian; almost all (96%) were non-immigrants.

varied from over one-third (35%) of the lowest income quintile, to less than one-tenth (8%) of the highest income quintile. Not unexpectedly immigrants were far more likely than non-immigrants to be visible minorities (43% versus 3%), though within immigrants, the proportion of visible minorities varied from over half in the lowest income quintile (52%), to less than one-third (30%) in the highest. Over one-third of immigrants had less than high school graduation (36%), compared to about one-quarter of non-immigrants (26%). Compared to non-immigrants, immigrants were less likely to have a university degree (16% versus 24%), and somewhat more likely to have government transfers as their major source of income (16% versus 13%). Among non-immigrants, the percentage of Aboriginal people was 3% in the lowest income quintile, compared to less than 1% in the highest.

Disparities in remaining years of life at age 25 years

Remaining years of life expectancy at age 25 years (conditional on surviving to age 25 years) are shown in Table 4. For all cohort members of each sex in the study area (including both immigrants and non-immigrants), there was a clear gradient across the income quintiles, with higher life expectancy in each successively richer quintile. The difference in remaining life expectancy between the lowest and highest income quintiles was 5.3 years for men and 3.3 years for women.

For non-immigrants, the income gradient in remaining life expectancy between the lowest and the highest income quintiles was 9.8 years for men and 7.4 years for women.

TABLE 4
Remaining life expectancy at age 25 years (conditional on surviving to age 25 years), by income adequacy quintile and sex, by immigrant status, City of Toronto and Region of Peel, 1991–2001

Immigrant status Income quintile	Men		Women	
	Years (95% CI)		Years (95% CI)	
Immigrants ^a and non-immigrants				
Total, all quintiles	53.7	(53.5, 53.9)	59.3	(59.1, 59.5)
Quintile 1 (lowest)	50.6	(50.2, 51.0)	57.1	(56.7, 57.5)
Quintile 2	53.0	(52.6, 53.4)	59.2	(58.8, 59.6)
Quintile 3	54.0	(53.6, 54.4)	59.7	(59.2, 60.1)
Quintile 4	55.0	(54.6, 55.4)	60.6	(60.2, 61.1)
Quintile 5 (highest)	56.0	(55.5, 56.4)	60.4	(60.0, 60.9)
Difference Q5–Q1	5.3	(4.7, 5.9)	3.3	(2.7, 3.9)
Immigrants ^a				
Total, all quintiles	55.4	(55.1, 55.6)	60.9	(60.6, 61.1)
Quintile 1 (lowest)	53.8	(53.3, 54.3)	60.3	(59.8, 60.8)
Quintile 2	55.0	(54.5, 55.5)	60.7	(60.1, 61.2)
Quintile 3	55.6	(55.0, 56.1)	60.9	(60.3, 61.5)
Quintile 4	56.4	(55.7, 57.0)	61.2	(60.5, 61.9)
Quintile 5 (highest)	57.6	(56.9, 58.3)	61.1	(60.3, 61.8)
Difference Q5–Q1	3.8	(3.0, 4.7)	0.8	(-0.1, 1.7)
Non-immigrants				
Total, all quintiles	51.7	(51.4, 52.0)	57.6	(57.4, 57.9)
Quintile 1 (lowest)	45.1	(44.4, 45.9)	52.5	(51.8, 53.2)
Quintile 2	49.7	(49.0, 50.4)	57.3	(56.7, 58.0)
Quintile 3	51.7	(51.1, 52.3)	58.4	(57.7, 59.0)
Quintile 4	53.6	(53.0, 54.1)	60.1	(59.4, 60.7)
Quintile 5 (highest)	55.0	(54.5, 55.5)	60.0	(59.4, 60.5)
Difference Q5–Q1	9.8	(8.9, 10.7)	7.4	(6.5, 8.3)

Source: Special tabulations from the 1991–2001 Canadian census mortality follow-up study.⁴

Abbreviations: CI, confidence interval; Q, quintile.

^a Foreign born, including non permanent residents.

For immigrants, the income gradient in remaining life expectancy was markedly less steep. The gap between the highest and lowest quintiles was 3.8 years for immigrant men and 0.8 years for immigrant women.

Note that within each income quintile and for both sexes, the remaining life expectancy of immigrants always exceeded that of non-immigrants. However, the differences between immigrants and non-immigrants were smallest in the highest income quintile (2.6 years for men, 1.1 years for women) and largest in the lowest (8.7 years for men, 7.8 years for women).

Disparities in the probability of survival to age 75 years

The probability of surviving to age 75 years (conditional on surviving to age 25 years) is shown in Table 5. As with life expectancy at age 25 years, the proportion of men and women expected to survive to age 75 years increased in each successively higher income quintile, for all cohort members as well as for both immigrants and non-immigrants. However, the disparities were much more striking for non-immigrants.

For all cohort members of each sex there was a clear gradient across the income quintiles, with higher probability of survival to age 75 years in each successively richer quintile. Among men, the probability of survival to age 75 years was 57% in the lowest income quintile and 74% in the highest (a difference of 17 percentage points). Among women, the probability of survival to age 75 years ranged from 73% in the lowest income quintile to 84% in the highest (a difference of 10 percentage points).

For non-immigrant men, the probability of survival to age 75 years was 40% in the lowest income quintile and 73% in the highest (a difference of 33 percentage points). For immigrant men, the probability of survival to age 75 years was 67% for those in the lowest income quintile and 76% for those in the highest (a difference of 9 percentage points).

For non-immigrant women, the probability of survival to age 75 years ranged from 61% in the lowest income quintile to 82% in

TABLE 5
Probability of survival to age 75 years (conditional on surviving to age 25 years), by income adequacy quintile and sex, by immigrant status, City of Toronto and Region of Peel, 1991–2001

Immigrant status Income quintile	% Probability (95% CI)	
	Men	Women
Immigrants and non immigrants		
Total, all quintiles	66.9 (66.3, 67.5)	80.1 (79.5, 80.6)
Quintile 1 (lowest)	57.0 (55.5, 58.5)	73.3 (72.0, 74.5)
Quintile 2	64.1 (62.7, 65.5)	79.5 (78.4, 80.7)
Quintile 3	67.3 (66.0, 68.7)	81.8 (80.6, 82.9)
Quintile 4	69.5 (68.2, 70.8)	82.9 (81.7, 84.1)
Quintile 5 (highest)	74.1 (72.9, 75.4)	83.6 (82.4, 84.7)
Difference Q5–Q1	17.2 (15.2, 19.1)	10.3 (8.6, 12.0)
Immigrants^a		
Total, all quintiles	71.5 (70.7, 72.3)	83.6 (82.9, 84.3)
Quintile 1 (lowest)	67.2 (65.4, 69.1)	81.0 (79.5, 82.4)
Quintile 2	69.3 (67.6, 71.0)	82.4 (80.9, 83.8)
Quintile 3	72.3 (70.6, 74.0)	85.1 (83.7, 86.6)
Quintile 4	73.1 (71.3, 74.9)	85.3 (83.7, 86.9)
Quintile 5 (highest)	75.8 (74.0, 77.7)	85.4 (83.6, 87.2)
Difference Q5–Q1	8.6 (6.0, 11.2)	4.4 (2.1, 6.7)
Non immigrants		
Total, all quintiles	61.0 (60.0, 62.0)	76.0 (75.2, 76.9)
Quintile 1 (lowest)	39.7 (37.3, 42.2)	60.9 (58.6, 63.1)
Quintile 2	54.5 (52.0, 56.9)	75.1 (73.2, 77.1)
Quintile 3	59.7 (57.5, 61.9)	77.6 (75.8, 79.5)
Quintile 4	65.1 (63.1, 67.2)	80.2 (78.5, 82.0)
Quintile 5 (highest)	72.9 (71.2, 74.6)	82.3 (80.8, 83.9)
Difference Q5–Q1	33.1 (30.2, 36.1)	21.5 (18.7, 24.2)

Source: Special tabulations from the 1991–2001 Canadian census mortality follow-up study.¹

Abbreviations: CI, confidence interval; Q, quintile.

^a Foreign born, including non permanent residents.

the highest (a difference of 21 percentage points). For immigrant women, the probability of survival to age 75 years ranged from 81% in the lowest income quintile to 85% in the highest (a difference of 4 percentage points).

Note that in each income quintile and for both sexes, the probability of survival to age 75 years for immigrants always exceeded that for non-immigrants. However, the difference between immigrants and non-immigrants was largest in the lowest income quintile (28 percentage points for men, 20 percentage points for women), and smallest in the highest (3 percentage points for both men and women).

Discussion

Results from this study clearly show that for both men and women in the City of Toronto and Region of Peel, remaining life expectancy at age 25 years and probability of

survival to age 75 years differed substantially across income quintiles. That was not surprising, though data with individual and family-level income were required to demonstrate it. We also found that the disparities in mortality by income were much greater when the analysis was restricted to non-immigrants. Moreover, within each income quintile, immigrants had more favourable results compared to non-immigrants, but the immigrant advantage was particularly marked within the lowest income quintiles. Neither the greater disparities in mortality by income among non-immigrants, nor the greater survival advantage for immigrants in lower income groups has previously been reported for Canada.

The failure of our previous small-area based study to detect differences in life expectancy across neighbourhood income quintiles was likely because of considerable confounding due to the presence of a

much higher than average proportion of low-mortality immigrants (and especially of recent immigrants, with particularly low mortality) within otherwise high-mortality low-income neighbourhoods, as well as non-differential misclassification due to the use of census tract averages rather than individual and family income.

In terms of both remaining life expectancy and probability of survival to age 75 years, these results not only confirm previous work by showing substantial disparities by income overall, but they also reveal that the income gradient in mortality was much steeper among non-immigrants compared to immigrants.

The healthy immigrant effect presumably reflects a high degree of self-selection. First, people are less likely to try to immigrate if they are unhealthy. Second, the immigration process requires that immigrants undergo medical screening to enter Canada, and immigrants are selected based on their wealth, employability,⁹ education, and language abilities.¹⁷ Third, unhealthy behaviours such as smoking, heavy drinking and poor diet tend to be less common among immigrants compared to non-immigrants.^{9,18}

Research has shown that immigrants in general tend to enjoy better health than do non-immigrants. This has been observed for a variety of chronic diseases as well as disability, dependency, life expectancy and disability-free life expectancy.^{17,24} Although immigrants are usually in excellent health upon arrival in Canada, over time their health status tends to converge toward that of the Canadian-born population.^{7,25} In particular, research has shown that recent immigrants have lower mortality rates compared to longer-term immigrants.⁵ The larger gap between immigrants and non-immigrants that we observed in the lower income quintiles compared to the higher income quintiles appears to be related, at least in part, to the higher proportion of recent immigrants in the lower income quintiles. Future studies with adequate power should attempt to control for such confounding.

Limitations

The 1991–2001 Canadian census mortality follow-up study excluded people who were missed by the 1991 census (about 3.4% of the total population). The missed individuals were more likely to be young, mobile, low income, of Aboriginal ancestry²⁶ or homeless. In addition, people residing in long-term care facilities, seniors' residences or prisons (who were not enumerated by a long-form questionnaire), and non-tax filers in both the 1990 and 1991 tax years (as this information was needed for the linkage) were excluded from the cohort. As a result, the entire cohort across Canada had one year longer remaining life expectancy for men, and two years longer remaining life expectancy for women when compared to life tables for the entire population of Canada.⁵

Information on family income and place of residence was only available at baseline. Since these characteristics are expected to change over time, it would have been preferable to have income and place of residence for each year of follow-up.

Because this analysis was restricted to the City of Toronto and Region of Peel, our cohort had insufficient numbers to allow us to further distinguish between recent and long-term immigrants, except in terms of population characteristics. Future analyses using the entire cohort should both do so and examine other factors such as country or region of origin and visible minority status to better understand the trends by income that we see in these data.²⁷

Conclusion

Our results highlight the importance of using individual and family level data when analysing income disparities in health outcomes in a population as diverse as that of Canada's largest metropolitan area. It also shows the importance of taking account of both immigrant status and recency of immigration in understanding the relationship between income and two basic health outcomes—remaining life expectancy at age 25 years and the probability of

survival to age 75 years. This is especially important for areas such as the City of Toronto and Region of Peel, which have a very high proportion of immigrants, including many recent immigrants.

While vital statistics death and birth registrations collect information on the birthplace of the decedent, or of the mother, that information is often overlooked when data are compiled and analysed. In other administrative datasets, such as cancer registries and hospital morbidity data, no information is collected on place of birth. This study demonstrates the importance of collecting and analysing this type of data, not just for understanding the relationships between immigration and health (though that is important), but also for clarifying the extent and nature of socio-economic disparities in health more generally.

Future work could investigate ways of including the morbidity and mortality experience of institutional residents—the most disabled segment of the population—as well as that of people aged less than 25 years, to get a more comprehensive picture of morbidity and mortality in relation to socio-economic position.³ Analyses examining causes of death within each of the quintiles would further enhance knowledge with regard to potential prevention efforts intended to reduce health disparities related to socio-economic circumstances.

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Appendix

TABLE A

Remaining life expectancy at age 25, by neighbourhood income quintile, Peel Region, 2005

Neighbourhood income quintile	Years remaining	
	Men	Women
Quintile 1 (lowest)	56.6	61.1
Quintile 2	57.3	60.6
Quintile 3	56.8	61.0
Quintile 4	57.3	59.9
Quintile 5 (highest)	57.0	59.4
Difference: Q5-Q1	+0.4	-1.7

Source: Stratton J et al. 2010¹⁰. Special tabulations based on Ontario Mortality Database 2005, HELPS (Health Planning System), Ministry of Health Promotion; and 2006 census tract profiles, Statistics Canada.

Note: Neighbourhood income quintiles based on census tract proportion of people whose economic family or individual income was less than the Statistics Canada low income cut off for the applicable family size and community size group.

References

1. Wolfson MC, Kaplan G, Lynch J, Ross N, Backlund E. Relation between income inequality and mortality: empirical demonstration. *West J Med.* 2000 Jan;172(1):22-4.
2. Wilkins R, Berthelot JM, Ng E. Trends in mortality by neighbourhood income in urban Canada from 1971 to 1996. *Health Rep.* 2002;13 (suppl):1-27.
3. McIntosh CN, Finès P, Wilkins R, Wolfson MC. Income disparities in health adjusted life expectancy for Canadian adults, 1991 to 2001. *Health Rep.* 2009 Dec;20(4):55-64.
4. Pampalon R, Hamel D, Gamache P. A comparison of individual and area based socio-economic data for monitoring social inequalities in health. *Health Rep.* 2009 Sep;20(3):85-94.
5. Wilkins R, Tjepkema M, Mustard C, Choinière R. The Canadian census mortality follow up study, 1991 through 2001. *Health Rep.* 2008 Sep;19(3):25-43.
6. Lynch J, Harper S, Kaplan GA, Davey Smith G. Associations between income inequality and mortality among US states: the importance of time period and source of income data. *Am J Public Health.* 2005 Aug;95(8):1424-30.
7. Kliewer EV, Ward RH. Convergence of immigrant suicide rates to those in the destination country. *Am J Epidemiol.* 1988 Mar;127(3):640-53.
8. Sharma RD, Michalowski M, Verma RB. Mortality differentials among immigrant populations in Canada. *Int Migr.* 1990 Dec;28(4):443-50.
9. Chen J, Wilkins R, Ng E. Health expectancy by immigrant status, 1986 and 1991. *Health Rep.* 1996 Winter;8(3):29-38.
10. DesMeules M, Gold J, McDermott S, Cao Z, Payne J, LaFrance B, et al. Disparities in mortality patterns among Canadian immigrants and refugees, 1980-1998: results of a national cohort study. *J Immigr Health.* 2005 Oct;7(4):221-32.
11. Trovato F, Odynek D. Sex differences in life expectancy in Canada: immigrant and native born populations. *J Biosoc Sci.* 2011 May;43(3):353-67.
12. Saposnik G, Redelmeier DA, Li H, Fuller Thomson E, Lonn E, Ray JG. Myocardial infarction associated with recency of immigration to Ontario. *QJM.* 2010 Apr;103(4):253-8.
13. Pampalon R, Hamel D, Gamache P. Health inequalities, deprivation, immigration and aboriginality in Canada: a geographic perspective. *Can J Public Health.* 2010 Nov Dec;101(6):470-4.
14. Ng E. Longitudinal Health and Administrative Data Research Team. Insights into the healthy immigrant effect: mortality by period of immigration and birthplace. Health Analysis Division Working Paper Series. Ottawa (ON): Statistics Canada; 2011 September. 16 pp. [Statistics Canada, Catalogue No.: 82-622-XIE2011008]
15. Ng E. The healthy immigrant effect and mortality rates. *Health Rep.* 2011;22(4):1-5.
16. Chiang CL. The life table and its applications. Malabar (FL): Robert E Krieger Publ Co; 1984.
17. Hynnyn I. Immigration and health: reviewing evidence of the healthy immigrant effect in Canada. CERIS Working Paper No. 55. Toronto (ON): Joint Centre of Excellence for Research on Immigration and Settlement; 2007 Apr.
18. Pérez CE. Health status and health behaviour among immigrants. *Health Rep.* 2002;13(suppl):1-12.
19. Singh GK, Miller BA. Health, life expectancy, and mortality patterns among immigrant populations in the United States. *Can J Public Health.* 2004 May Jun;95(3):14-21.
20. DesMeules M, Gold J, Kazanjian A, Manuel D, Payne J, Vissandée B, McDermott S, Mao Y. New approaches to immigrant health assessment. *Can J Public Health.* 2004 May Jun;95(3):22-6.
21. Singh GK, Siahpush M. All cause and cause specific mortality of immigrants and native born in the United States. *Am J Public Health.* 2001 Mar;91(3):392-9.
22. Singh GK, Hlati RA. Trends and disparities in socioeconomic and behavioural characteristics, life expectancy, and cause specific mortality of native born and foreign born populations in the United States, 1979-2003. *Int J Epidemiol.* 2006 Aug;35(4):903-19.
23. Hajat A, Blakely T, Dayal S, Jatrana S. Do New Zealand's immigrants have a mortality advantage? Evidence from the New Zealand Census Mortality Study. *Eth Health.* 2010 Oct;15(5):531-47.

-
24. Singh GK, Siahpush M. Ethnic immigrant differentials in health behaviors, morbidity and cause specific mortality in the United States: an analysis of two national databases. *Hum Biol.* 2002 Feb;74(1):83-109.
 25. Newbold KB. Self-rated health within the Canadian immigrant population: risk and the healthy immigrant effect. *Soc Sci Med.* 2005 Mar;60(6):1359-70.
 26. Statistics Canada. Coverage, 1991 Census Technical Reports; Reference Products Series. Ottawa (ON): Minister of Industry, Science and Technology; 1994. [Statistics Canada, Catalogue No.: 92-341].
 27. McDonald JT, Kennedy S. Insights into the 'healthy immigrant effect': health status and health service use of immigrants to Canada. *Soc Sci Med.* 2004 Oct;59(8):1613-27.
 28. Stratton J, Mowat DL, Wong KP. Remaining life expectancy at age 25, by neighbourhood income quintile, Peel Region, 2005. Brampton (ON): Region of Peel Public Health, 2010.

Prevalence of meeting physical activity guidelines for cancer prevention in Alberta

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Abstract

Introduction: Guidelines for recommended physical activity (PA) levels have been developed by the Canadian Society for Exercise Physiology (CSEP) and the U.S. Department of Health and Human Services (USDHHS) for health benefits and by the American Cancer Society (ACS) and the World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) for cancer prevention benefits.

Methods: We examined if these guidelines were met using a sample of 14 294 Albertan participants of the Tomorrow Project, aged 35 to 64 years, enrolled from 2001 to 2005. We used logistic regression to examine correlates of leisure PA behaviour.

Results: An estimated 55%, 42%, 26% and 23% of participants met CSEP, ACS, USDHHS, and WCRF/AICR guidelines, respectively. Women were less likely than men to meet ACS (Odds Ratio [OR] = 0.72, 95% confidence interval [CI]: 0.55–0.93), USDHHS (OR = 0.67, 95% CI: 0.50–0.89) and WCRF/AICR (OR = 0.63, 95% CI: 0.47–0.85) guidelines, and being obese was correlated with not meeting USDHHS (OR = 0.45, 95% CI: 0.32–0.65) and WCRF/AICR guidelines (OR = 0.79, 95% CI: 0.63–0.98).

Conclusion: Albertans, particularly women and obese individuals, are not sufficiently active for cancer prevention benefits.

Keywords: physical activity, cancer prevention, population health, lifestyle, health behaviour, guidelines

Introduction

Cancer remains the second leading cause of mortality and morbidity in Canada with an estimated 177 800 incident cases and 75 000 deaths in 2011.¹ The total economic cost of cancer has been estimated to represent roughly 9% of the total cost of illness in Canada.² Whilst treatment and early detection have improved over the

past decades, cancer prevention by modifying environmental and lifestyle risk factors remains the most viable long-term strategy for substantially reducing the burden of cancer in Canada.³ Several modifiable lifestyle risk factors have been extensively investigated including tobacco use, alcohol use, dietary intake, sun exposure and, more recently, physical activity (PA).^{4,5}

Evidence that PA is a key modifiable lifestyle risk factor that may reduce the risk of several cancers is now accumulating. The risk of colon, breast and endometrial cancers is reduced by 25% to 30% in physically active individuals, and evidence for a beneficial effect of PA in reducing prostate, ovarian, lung and other gastrointestinal cancers is emerging.^{6,9} The evidence for a role of PA in cancer etiology is now considered to be fairly strong, consistent and biologically plausible. Several biological mechanisms have been hypothesized to explain how PA reduces cancer risk, including an impact on endogenous sex and metabolic hormone levels, growth factors, inflammation and insulin resistance, all of which impact carcinogenesis.^{10,12} In addition, PA may act to decrease cancer risk by decreasing obesity and central adiposity, both established risk factors for colon, postmenopausal breast, endometrial, kidney and oesophageal cancers.^{12–14} Overweight and obesity result in a shift in the sex and metabolic hormone balance in the body and influence the availability of a number of growth factors involved in the insulin resistance and inflammation pathways that initiate and promote carcinogenesis.¹⁴ As a result, PA can also be used for weight management to reduce cancer risk.^{12–14}

This overwhelming evidence that PA plays an important role in preventing cancer and other chronic diseases has driven the development of PA recommendations or guidelines by a number of organizations.

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The purpose of these guidelines is to encourage inactive populations to engage in PA and to provide a target to set personal PA goals and measure progress.¹⁵ In Canada, the Canadian Society for Exercise Physiology (CSEP) has developed guidelines for adults, older adults and children.¹⁶ The 2003 CSEP guidelines recommend that adults engage in at least 150 minutes of moderate to vigorous aerobic PA per week. The guidelines also indicate that more PA provides greater health benefits.¹⁶ Moderate-intensity activity is defined as aerobic activity that is not exhausting and leads to light perspiration (e.g. brisk walking), while vigorous activity results in rapid heart rates, sweating and heavy breathing (e.g. jogging, aerobics).^{17,18} CSEP also recommends that adults incorporate strength training activities at least two days per week; however, our study focuses only on levels of aerobic activity.

The American Cancer Society (ACS),¹⁹ the United States Department of Health and Human Services (USDHHS) with the United States Department of Agriculture,²⁰ and the World Cancer Research Fund with the American Institute for Cancer Research (WCRF/AICR)²¹ also recommend a minimum of 150 minutes of moderate to vigorous PA per week for general health. Further, they have extended their recommendations to include higher levels of activity to prevent other chronic diseases. Based on reviews of current research, ACS recommended at least 45 minutes of moderate and preferably vigorous PA at least 5 days per week to reduce cancer risk. USDHHS recommended that adults engage in at least 30 minutes of moderate-intensity PA on most days of the week as a means of reducing the risk of chronic diseases. However, USDHHS also recommended that adults engage in 60 minutes of moderate to vigorous activity on most days of the week to help manage body weight and prevent weight gain, and 60 to 90 minutes of daily moderate to vigorous activity for sustained weight loss to reduce the risk of chronic disease, including cancer, associated with overweight and obesity.²⁰ Most recently, WCRF/AICR conducted a comprehensive review of current evidence and recommended that adults aim to participate in at least 60 minutes of moderate activity or 30 minutes or more of vigorous activity daily as a means of reducing cancer risk.²¹

Using data from the Alberta cohort study known as the Tomorrow Project,²² our aim was to estimate the percentage of Albertans meeting the PA guidelines for cancer prevention. Since there has been little research on the levels of PA necessary for cancer prevention, this study also explored potential associations between personal and demographic characteristics and meeting PA guidelines for cancer prevention.

Methods

Study sample

The Population Research Laboratory at the University of Alberta recruited Tomorrow Project participants from all geographic regions of Alberta using the Random Digit Dialing (RDD) method.²³ This method was selected for random population sampling because 97% of Alberta households had at least one telephone line in 2000.²⁴ Participants were sampled from over 400 cities, towns and villages and from all rural areas throughout the province to build a geographically representative sample.²²

A total of 29 270 Albertans aged 35 to 65 years were recruited to the Tomorrow Project from 2001 to 2005, or 49% of the 59 735 eligible individuals who responded positively to telephone calls; the number of eligible individuals who did not respond to telephone calls is unknown, so the response rate cannot be calculated. Of the 29 270 people recruited, 16 040 had complete data for lifestyle risk factors. A total of 1746 participants were excluded from this study sample based on the established exclusion criteria: transgendered ($n = 2$), over 65 years old ($n = 1328$), pregnant ($n = 55$), prior cancer diagnosis ($n = 188$), not resident in Alberta ($n = 75$), and being underweight ($n = 98$). Data for the remaining 14 294 Tomorrow Project participants were used for this analysis. We can conclude that the response rate cannot be greater than 25% ($14\ 294 / [59\ 735 - 1746]$).

This study received approval by the ethics review boards of the University of Calgary and the former Alberta Cancer Board, now part of Alberta Health Services—Alberta Cancer Research Ethics Committee.

Data collection

Albertans who consented to participate in the Tomorrow Project completed the self-administered, mailed questionnaires about lifestyle risk factors and exposures. Data collected using the Past Year Total Physical Activity Questionnaire (PYTPAQ) and the Health and Lifestyle Questionnaire (HLQ) were analyzed in this study. The PYTPAQ is a valid and reliable self-administered questionnaire used to collect the frequency, duration and intensity of occupational, household, active transport and leisure activities of the previous twelve months.²⁵ The PYTPAQ was correlated with 7-day activity logs (Spearman rank correlation [ρ] = 0.41) and 7-day accelerometer measurements ($\rho = 0.26$). The HLQ was developed from pre-existing questionnaires, including those used in the Canadian Community Health Survey (CCHS) cycle 1.1,²⁶ the Prostate, Lung, Colorectal and Ovarian Cancer Screening Trial,²⁷ and the European Prospective Investigation into Cancer and Nutrition²⁸ to assess health history, family history, cancer screening practices, smoking, stress, social support and demographic characteristics.

Participating in sufficient leisure activity to meet the PA guidelines recommended by CSEP, ACS, USDHHS and WCRF/AICR was the outcome of interest for this study. While occupational, household and transportation activities can also contribute to overall health, leisure activity is the most modifiable type of activity and has been the main target of public health promotion of PA.^{15,19,21} Four outcome variables were derived from data collected using the PYTPAQ. Metabolic Equivalents (MET) values, the ratio of energy expenditure of an activity to the energy cost of the metabolic rate at rest,¹⁸ were assigned to each reported leisure, household, occupational and active transport activity using the Compendium of Physical Activities.²⁹ Reported values for frequency and duration for each separate activity with intensity of 3 or more METs (considered a moderate intensity) were multiplied for a single estimate of the hours per week at moderate and vigorous intensity. Outcome variables were derived as follows:

- To meet the CSEP guidelines of at least 2.5 hours/week of moderate to vigorous activity;

- To meet the ACS guidelines of at least 3.75 hours/week of moderate to vigorous activity;
- To meet the WCRF/AICR guidelines of at least 7 hours/week of moderate-intensity activity or 3.5 hours/week of vigorous activity;
- To meet the USDHHS guidelines of at least 5 hours/week of moderate to vigorous activity to prevent weight gain.

Pertinent explanatory variables obtained from the HLQ included age, sex, annual household income, educational attainment, marital status, employment status, pre-existing chronic conditions (including hypertension, hypercholesterolemia and diabetes), self-rated health status, smoking behaviour, social support (using the Medical Outcomes Study Social Support Survey)³⁰ and urban or rural residence (from postal codes).

Statistical analysis

Univariate analysis provided an overall description of the study sample and an estimate of the percentage of the study sample that met each of the PA guidelines. We used the Cochran-Armitage test to assess trends across proportions that met each guideline.

Characteristics of the study sample and of the Alberta population, using 2001 Canadian census data,³¹ were compared to assess the representativeness of the sample. Prevalence of smoking and weight status were obtained from the CCHS 2.1. The CCHS 2.1 had a response rate of about 83% in Alberta in 2003 and reflects population-based estimates of health.³² A postal code conversion file from Statistics Canada was used to code participants into health regions. Sample weights were estimated using the distribution weights of age group and sex by health region of residence as well as by educational attainment and annual household income according to Canadian 2001 census data. The proportion of the sample that met each guideline was then weighted to obtain estimates of the percentage of Albertans that met each of the guidelines.

Logistic regression was used to explore the potential correlates of meeting each guideline. Prior to modelling, the data were assessed for multicollinearity.³³ Variable selection was done through hierarchical backward elimination,³⁴ beginning with all available explanatory variables and all models adjusted for age, sex and BMI. A 10-fold cross-validation procedure was used to avoid overfitting.³⁵ For each guideline, data were divided into 10 randomly selected subsets and variable selection was conducted using each of 9 training sets. The resulting model was fit to a test subset, repeating this procedure 10-fold until each subset was used as a test subset.³⁵ Variables selected in at least 3 of 10 folds at a significance level of $p = .05$, were included in the final models. Estimated coefficients and their standard errors were averaged across the folds and used to yield odds ratio (OR) estimates and 95% confidence intervals (CIs). Final models were fit to the entire sample and tested for goodness-of-fit using the Hosmer-Lemeshow test, for predictive value using receiver operating characteristic (ROC) curves, and for appropriateness of the logit link.³⁶ All statistical procedures were performed using STATA version 10 (StataCorp LP).³⁷

Results

Study sample characteristics

The study sample was largely female (60%) and averaged 49 years of age (Table 1). Most participants were of high socio-economic status, with one-third having some university education or higher (33%) and an annual household income of \$80,000 or higher (37%). Most were married or living with a common-law partner (77%), employed (77.5%) and urban residents (80%). Most of the sample self-rated their health as very good or better (61%), yet the majority were overweight (39%) and obese (25%) (Table 1). In comparison to the Alberta population, the study participants were more likely to be female, older, more educated and wealthier (Table 2). Study participants were also more likely to be overweight and obese and less likely to smoke than the Alberta population (Table 2). Overall, the sample represented all nine former health regions in Alberta.

Meeting physical activity guidelines

Those who met CSEP and ACS guidelines (63% and 48%, respectively) mainly participated in leisure activities rather than in household, occupational or active transport activities (Table 3). On the other hand, participants were most likely to meet USDHHS and WCRF/AICR guidelines through occupational activity. Regardless of the type of activity considered, participants were most likely to meet CSEP guidelines (93%) and least likely to meet USDHHS and WCRF/AICR guidelines (78% and 72%, respectively) (Table 3).

Prevalence of meeting physical activity guidelines in Alberta

After weighting by age, sex, and health region of residence and then by educational attainment and household income, 55% of the overall Alberta population was estimated to be sufficiently active to meet CSEP guidelines for general good health. However, the proportions of Albertans estimated to meet the more rigorous guidelines set by ACS, USDHHS and WCRF/AICR were comparatively low: 42%, 26% and 23%, respectively (Figure 1).

Correlates of meeting physical activity guidelines through leisure activity

Overall, marital status, employment status, annual household income and self-rated health status were correlated with meeting all PA guidelines through leisure activity (Table 4). Divorced, separated or widowed participants were more likely to meet CSEP (OR = 1.54; 95% CI: 1.06–2.26), ACS (OR = 1.63; 95% CI: 1.12–2.35), USDHHS (OR = 1.62; 95% CI: 1.08–2.43), and WCRF/AICR (OR = 1.51; 95% CI: 1.09–2.10) guidelines than those who were married or single. Retired participants were also more likely to meet all guidelines than those who were employed or unemployed. However, this strength of association increased with increasingly demanding guidelines: retirees were almost 3 times more likely to meet WCRF/AICR guidelines (OR = 2.76; 95% CI: 1.57–4.87) compared to over 2 times more likely to meet CSEP guidelines (OR = 2.30; 95% CI: 1.32–4.01). In contrast, the strength of

TABLE 1
Study sample characteristics, Alberta, 2005

Variable	Whole sample n = 14 294 %	Men n = 5729 %	Women n = 8565 %
Mean age (SD), years (n = 13 970)	48.7 (7.9)	48.6 (7.9)	48.7 (8.0)
BMI, % (n = 13 970)			
18.5–24.9 kg/m ²	35.4	24.6	42.7
25.0–29.9 kg/m ²	39.4	49.3	32.7
30.0–39.9 kg/m ²	22.5	24.7	21.0
≥ 40 kg/m ²	2.7	1.5	3.5
Marital status, % (n = 14 216)			
Married/Common law	76.9	81.9	75.4
Divorced, separated or widowed	15.2	10.7	18.5
Single	6.5	7.3	6.1
Educational attainment, % (n = 14 005)			
Some high school	8.6	8.9	8.4
High school diploma	18.6	15.0	21.0
Technical school/College training	39.9	40.7	39.3
Some university/University degree	22.9	22.7	22.9
Postgraduate university	10.1	12.6	8.4
Employment status, % (n = 14 051)			
Employed full-time	60.7	80.6	47.4
Employed part-time	16.8	5.6	24.2
Unemployed	13.5	5.0	19.1
Retired	8.0	7.2	8.5
Self-employed	1.0	1.4	0.8
Annual household income, % (n = 14 022)			
< \$20,000	6.0	3.6	7.5
\$20,000–\$39,999	16.6	12.1	19.6
\$40,000–\$59,999	20.0	19.3	20.4
\$60,000–\$79,999	20.1	21.6	19.1
\$80,000–\$99,999	14.5	16.0	13.4
≥ \$100,000	22.9	27.3	19.9
Place of residence, % (n = 14 294)			
Rural	19.6	19.9	20.0
Urban	80.4	80.1	80.0
Self-rated health status, % (n = 14 036)			
Excellent	17.3	15.8	18.3
Very Good	43.4	43.2	43.6
Good	33.4	35.3	32.1
Fair	5.3	5.2	5.3
Poor	0.6	0.4	0.7
Current smoking status, % (n = 14 151)			
Non-smoker	80.5	79.8	80.9
Occasional	3.5	3.8	3.2
Daily	16.0	16.4	15.8
Hypertension, % (n = 14 031)			
Yes	19.5	21.7	18.0
Hypercholesterolemia, % (n = 14 022)			
Yes	24.8	29.8	21.4
Diabetes, % (n = 14 237)			
Yes	3.8	4.5	3.3

Abbreviations: BMI, body mass index; SD, standard deviation.

association between an annual household income of \$100,000 or higher and meeting CSEP guidelines (OR = 2.51; 95% CI: 1.36–4.63) was higher than for meeting WCRF/AICR guidelines (OR = 1.56; 95% CI: 1.06–3.27). Participants who rated their health as good or worse were significantly less likely to meet CSEP guidelines (OR = 0.54, 95% CI: 0.37–0.80), whereas participants with self-rated health status lower than excellent were significantly less likely to meet ACS (OR = 0.72; 95% CI: 0.52–0.99), USDHHS (OR = 0.72; 95% CI: 0.53–0.97) and WCRF/AICR (OR = 0.67; 95% CI: 0.47–0.95) guidelines (Table 4).

Sex and BMI were the only characteristics found to be significantly associated with sufficient activity to meet guidelines relevant for cancer prevention (Table 4). Women were less likely than men to meet guidelines recommended by ACS (OR = 0.72; 95% CI: 0.55–0.93), USDHHS (OR = 0.67; 95% CI: 0.50–0.89) or WCRF/AICR (OR = 0.63; 95% CI: 0.47–0.85), though there were no sex differences in meeting CSEP guidelines for general health. Being overweight was associated only with meeting USDHHS guidelines (OR = 0.52; 95% CI: 0.39–0.70), whereas being obese was associated with meeting both USDHHS (OR = 0.45; 95% CI: 0.32–0.65) and WCRF/AICR guidelines (OR = 0.79; 95% CI: 0.63–0.98).

Discussion

Our findings suggest that few Albertans are participating in sufficient leisure activity to reduce cancer risk, probably because of the higher levels of activity required to meet ACS or WCRF/AICR guidelines compared to CSEP guidelines for general health. Since the WCRF/AICR guidelines take almost 3 times as long as do the CSEP guidelines, participants need to commit more time to physical activity to benefit from cancer risk reduction. Thus, retired people, with more available leisure time, were more likely to be active at levels recommended for cancer prevention.

These findings are consistent with the Health Belief Model, which proposes that as perceived barriers for a behaviour

TABLE 2
Comparison of sociodemographic characteristics between the study sample (2005)
and the Alberta population (2001 Canadian Census data)

Sociodemographic characteristics	Study sample (%)	Alberta (%) ^a
Age range, years		
35–39	16.6	21.4
40–44	20.6	22.5
45–49	20.3	19.7
50–54	17.7	16.0
55–59	14.3	11.5
60–64	10.4	9.0
Sex		
Men	40.1	50.3
Women	59.9	49.7
BMI ^b		
18.5–24.9 kg/m ²	35.4	43.5
25.0–29.9 kg/m ²	39.4	38.1
≥ 30 kg/m ²	25.2	18.4
Current smoking status ^b		
Daily smoker	16.0	24.5
Educational attainment		
Some high school	8.6	22.3
High school diploma	18.6	16.0
Technical school/College training	39.9	29.1
Some university/University degree	22.9	27.4
Postgraduate university	10.1	5.1
Annual household income		
< \$20,000	5.8	32.6
\$20,000–\$39,999	16.2	29.3
\$40,000–\$59,999	19.5	19.3
\$60,000–\$74,999	19.7	8.2
≥ \$75,000	36.6	10.5

^a Data from 2001 Canada Census.¹¹

^b Data from Canadian Community Health Survey Cycle 2.1 (2003).¹²

increase, the likelihood of performing the health behaviour decreases.³⁸ Sufficient leisure activity to reduce cancer risk is likely associated with greater barriers related to time, competing commitments, and motivation than participating in the lower levels required for general health benefits. In addition, CSEP guidelines have been consistently communicated to Canadians since 1998.¹⁵ Canadians who aim to be active may be striving to meet CSEP guidelines for general health benefits without being aware that higher levels of activity are needed to reduce cancer risk. Perceived benefits, another component of the Health Belief Model, are also important to encourage behaviour;³⁸ increasing public awareness of the PA guidelines relevant to preventing cancer may encourage individuals to use these guidelines as a benchmark for being physically active.

In our study, women were less likely than men to participate in the levels of leisure activity recommended for cancer risk reduction, a finding consistent with other reports,^{39–41} even after controlling for other sociodemographic factors. A number of cultural and social contextual factors, such as gender roles, result in differences in PA behaviour between men and women.^{40–44} Motivating factors are also different; women more commonly report body image, appearance and health concerns as being equally important reasons for being physically active.^{45–48} These results

TABLE 3
Percentage of study population that met physical activity guidelines by organization and type of physical activity, Alberta, 2001–2005

Type of activity ^d	CSEP ^a		ACS ^b		USDHHS ^c		WCRF/AICR ^e		Trend p-value ^f
	n	%	n	%	n	%	n	%	
Leisure	8773	62.6	6734	48.1	4115	29.5	3377	24.1	< .0001
Household	7711	55.1	6034	43.1	4156	29.8	3689	26.3	< .0001
Occupation	5680	40.6	5387	38.5	4930	35.3	4841	34.6	< .0001
Active transport	470	3.4	162	1.2	50	0.4	72	0.5	< .0001
Total physical activity^d	12 965	92.6	12 322	88.0	10 912	78.1	10 132	72.4	< .0001

Abbreviations: ACS, American Cancer Society; AICR, American Institute for Cancer Research; CSEP, Canadian Society for Exercise Physiology; PA, physical activity; USDHHS, United States Department of Health and Human Services; WCRF, World Cancer Research Fund.

^a Minimum 2.5 hours/week of moderate to vigorous PA.

^b Minimum 3.75 hours/week of moderate to vigorous PA.

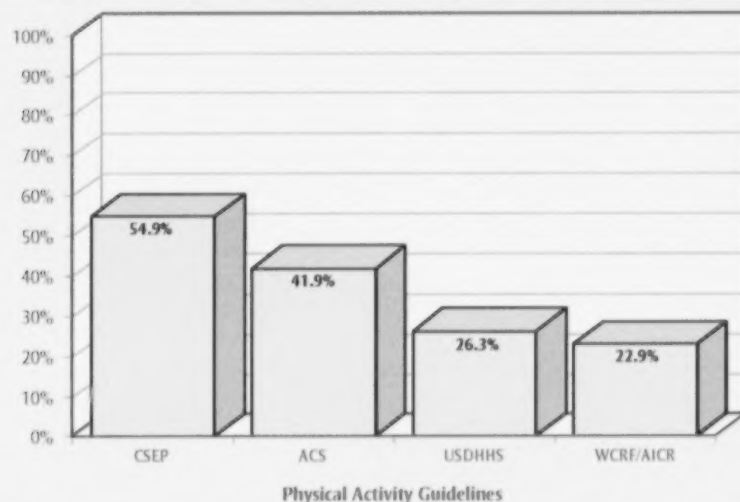
^c Minimum 5 hours/week of moderate to vigorous PA to prevent weight gain.

^d Minimum 7 hours/week of moderate-intensity PA or 3.5 hours/week of vigorous PA.

^e Cochran–Armitage test for trend.

^f Moderate- and vigorous-intensity activity.

FIGURE 1
Estimated^a Alberta population percentage that met physical activity guidelines through leisure activity, 2001–2005



Abbreviations: ACS, American Cancer Society; AICR, American Institute for Cancer Research; CSEP, Canadian Society for Exercise Physiology; USDHHS, United States Department of Health and Human Services; WCRF, World Cancer Research Fund.

^a Weighted by health region of residence, age and sex, and further weighted by household income and educational attainment using 2001 Census data.

suggest that gender differences need to be considered when prompting PA for cancer prevention in the population.

Despite gender differences, both men and women who were either overweight or obese were significantly less likely than normal weight individuals to meet USDHHS and WCRF/AICR guidelines. Given that these guidelines require 30 to 60 minutes of daily leisure PA, it is possible that overweight and obese individuals may be physically unable to take part in sufficient amounts of activity or make the lifestyle changes required to achieve these levels of activity. In fact, overweight and obese individuals are less likely than normal weight adults to adhere to PA programs, even those that involve only walking.^{49,50} PA may be especially challenging for those overweight and obese individuals with pain or discomfort exacerbated by their weight status.⁵¹ Alternatively, these results may reflect the fact that sufficient activity to meet USDHHS and WCRF/AICR guidelines aids in weight loss and protects from unhealthy weight.^{52,55} Either way, our results are consistent with other findings that overweight and obesity are independently associated with low levels of PA.^{51,56,57}

Individuals in the highest income category were the most likely to participate in sufficient activity to meet all guidelines, also consistent with previous findings.^{47,58,59} Low socio-economic status is often associated with caregiver responsibilities, time devoted to childcare, physical labour as an occupation, lack of transportation, unsafe neighbourhoods, inflexible work schedules and transient homes,⁴¹ all of which may hamper participation in leisure activity. Interestingly, the association between annual household income and meeting PA guidelines decreased in strength as the amount of activity needed to meet guidelines increased. This relation was weakest for meeting USDHHS and WCRF/AICR guidelines, suggesting that participation in high levels of leisure PA may be moderated by more complex intrapersonal factors. The weakening association between activity and income may also reflect that retirees were more frequently middle-class income earners, yet more likely to meet guidelines for cancer risk reduction. Despite this weaker relation, income was still strongly correlated with meeting guidelines for cancer prevention.

This study is among the first to investigate the prevalence of PA at levels sufficient for cancer prevention. So far, estimates of PA among Canadians have used the CSEP guidelines as the benchmark for sufficient activity for health benefits. Using this approach, the CCHS (cycle 2.1) estimated that during the time period of this study, 48% of Canadians⁶⁰ and 52% of Albertans,⁶¹ 35 to 65 years old, were physically active.⁶¹ In comparison, our current study estimated that 63% of Albertans were sufficiently active to meet CSEP guidelines (Table 3). This difference in estimates persisted even when the estimate was adjusted for age, sex, income and educational attainment, suggesting that the study sample differs from the Alberta population in other factors that need to be adjusted for when estimating population prevalence for PA, which is a complex behaviour. The higher estimate derived from our study could also be attributed to a "healthy enrollee" effect. About 60% of the study sample rated their health as very good or excellent, and the study sample had a lower prevalence of diabetes (3.8% compared to 4.9% for Albertans⁶²) and smoking than the Alberta population (16% of the study sample were daily smokers versus 25% of Albertans). Despite being more likely to be overweight and obese, study participants appeared to be healthier than Albertans as a whole and may have been more likely to participate in leisure PA. Differences in leisure PA measurement between the CCHS and the PYTPAQ used in our study may also account for the difference in prevalence estimates. The CCHS utilized a multi-part item to report frequency and duration of participation in a given list of leisure activities over the past three months.⁶² In contrast, the PYTPAQ assessed leisure activity over the past year using a more detailed approach that permitted participants to report duration, frequency and intensity of all recreational and sports activities. The PYTPAQ was more likely to reflect usual activity patterns, while the short time frame of the CCHS questionnaire may be more influenced by seasonal variation and acute illness.⁶³

During the study period, 45.9% of U.S. adults⁶⁴ and 29% of European Union adults from 15 countries⁶⁵ were estimated to participate in 150 minutes of moderate

TABLE 4
Estimated odds ratios^a for meeting physical activity guidelines through leisure activity, Alberta, 2001–2005

Variable	Guidelines			
	CSEP ^b OR (95% CI)	ACS ^c OR (95% CI)	USDHHS ^d OR (95% CI)	WCRF/AICR ^e OR (95% CI)
Age, years				
35–39	1.00	1.00	1.00	1.00
40–44	1.02 (0.69, 1.51)	0.99 (0.68, 1.44)	0.94 (0.63, 1.41)	0.91 (0.60, 1.39)
45–49	0.98 (0.66, 1.44)	0.98 (0.68, 1.43)	0.91 (0.61, 1.37)	0.87 (0.57, 1.34)
50–54	0.81 (0.54, 1.22)	0.86 (0.58, 1.27)	0.86 (0.56, 1.32)	0.82 (0.53, 1.29)
55–59	0.80 (0.52, 1.25)	0.80 (0.52, 1.24)	0.74 (0.46, 1.21)	0.75 (0.45, 1.24)
60–65	0.75 (0.44, 1.28)	0.72 (0.42, 1.22)	0.72 (0.40, 1.29)	0.67 (0.36, 1.24)
Sex				
Male	1.00	1.00	1.00	1.00
Female	0.85 (0.65, 1.11)	0.72 (0.55, 0.93)	0.67 (0.50, 0.89)	0.63 (0.47, 0.85)
BMI, kg/m ²				
18.5–24.9	1.00	1.00	1.00	1.00
25.0–29.9	0.96 (0.72, 1.28)	0.94 (0.71, 1.23)	0.52 (0.39, 0.70)	0.96 (0.71, 1.31)
≥ 30.0	0.82 (0.60, 1.14)	0.83 (0.60, 1.13)	0.45 (0.32, 0.65)	0.79 (0.63, 0.98)
Marital Status				
Married/Common law	1.00	1.00	1.00	1.00
Divorced, separated or widowed	1.54 (1.06, 2.26)	1.63 (1.12, 2.35)	1.62 (1.08, 2.43)	1.51 (1.09, 2.10)
Single	1.41 (0.84, 2.36)	1.50 (0.90, 2.49)	1.52 (0.87, 2.66)	1.52 (0.85, 2.71)
Educational attainment				
Some high school	1.00	1.00	1.00	1.00
High school diploma	1.20 (0.73, 1.95)	1.06 (0.64, 1.74)	0.91 (0.52, 1.61)	1.00 (0.55, 1.81)
Technical school/College	1.28 (0.81, 2.02)	1.10 (0.69, 1.75)	0.90 (0.53, 1.53)	0.93 (0.54, 1.61)
Some university/University degree	1.40 (0.85, 2.30)	1.22 (0.74, 2.01)	1.03 (0.59, 1.81)	1.12 (0.62, 2.01)
Postgraduate university	1.40 (0.78, 2.53)	1.08 (0.61, 1.92)	0.91 (0.48, 1.71)	0.97 (0.50, 1.87)
Employment status				
Employed full-time	1.00	1.00	1.00	1.00
Employed part-time	1.19 (0.84, 1.69)	1.27 (0.90, 1.78)	1.19 (0.81, 1.73)	1.11 (0.74, 1.67)
Unemployed	1.19 (0.81, 1.75)	1.27 (0.87, 1.86)	1.40 (0.92, 2.13)	1.41 (0.91, 2.18)
Retired	2.30 (1.32, 4.01)	2.65 (1.56, 4.48)	3.04 (1.74, 5.31)	2.76 (1.57, 4.87)
Self-employed	0.74 (0.21, 2.62)	0.76 (0.21, 2.77)	0.97 (0.22, 4.19)	1.20 (0.29, 4.99)
Annual household income				
< \$20,000	1.00	1.00	1.00	1.00
\$20,000–\$39,999	1.16 (0.66, 2.04)	1.14 (0.64, 2.04)	1.06 (0.55, 2.06)	0.99 (0.49, 1.98)
\$40,000–\$59,999	1.26 (0.71, 2.22)	1.27 (0.71, 2.26)	1.16 (0.60, 2.25)	1.03 (0.51, 2.06)
\$60,000–\$79,999	1.62 (0.90, 2.90)	1.52 (0.84, 2.75)	1.39 (0.71, 2.74)	1.20 (0.59, 2.43)
\$80,000–\$99,999	1.80 (0.97, 3.34)	1.79 (1.17, 2.75)	1.58 (0.78, 3.20)	1.30 (0.62, 2.73)
≥ \$100,000	2.51 (1.36, 4.63)	2.43 (1.32, 4.48)	2.05 (1.03, 4.08)	1.56 (1.06, 3.27)
Self-rated health status				
Excellent	1.00	1.00	1.00	1.00
Very Good	0.75 (0.52, 1.08)	0.72 (0.52, 0.99)	0.72 (0.53, 0.97)	0.67 (0.47, 0.95)
Good	0.54 (0.37, 0.80)	0.52 (0.36, 0.74)	0.50 (0.34, 0.73)	0.47 (0.32, 0.71)
Fair or Poor	0.38 (0.21, 0.71)	0.36 (0.19, 0.67)	0.37 (0.17, 0.78)	0.40 (0.19, 0.85)
Current smoking status				
Non-smoker	1.00	1.00	1.00	1.00
Occasional	1.14 (0.58, 2.23)	1.17 (0.62, 2.22)	1.16 (0.58, 2.31)	1.13 (0.56, 2.32)
Daily	0.65 (0.47, 0.90)	0.70 (0.50, 0.97)	0.77 (0.53, 1.13)	0.82 (0.55, 1.22)
Social Support ^f	1.12 (0.96, 1.31)	1.09 (0.94, 1.28)	1.08 (0.91, 1.28)	1.04 (0.87, 1.25)

Abbreviations: ACS, American Cancer Society; AICR, American Institute for Cancer Research; CI, confidence interval; CSEP, Canadian Society for Exercise Physiology; OR, odds ratio; USDHHS, United States Department of Health and Human Services; PA, physical activity; WCRF, World Cancer Research Fund.

Note: Bolded values are significant.

^a Estimated from logistic regression using 10-fold cross-validation.

^b Minimum 2.5 hours/week of moderate to vigorous PA.

^c Minimum 3.75 hours/week of moderate to vigorous PA.

^d Minimum 5 hours/week of moderate to vigorous PA to prevent weight gain.

^e Minimum 7 hours/week of moderate-intensity PA or 3.5 hours/week of vigorous PA.

^f Using the Medical Outcomes Study Social Support Survey.²⁰

to vigorous activity per week through large population-based surveys. Similarly, a recent study estimated that 15% of Canadian adults are active at these levels.⁶⁶ However, because these estimates included participation in occupational, transportation and household activities in addition to leisure PA, it is difficult to compare them with our estimates, which considered only leisure PA. Total PA has been used to estimate PA prevalence estimates in the different jurisdictions,^{64,67-69} but a focus on leisure PA is valuable since this type of activity is most likely to be modifiable, unlike occupational and household activities. Established evidence suggests that risk for breast, colorectal, prostate and endometrial cancers is significantly reduced when higher intensity PA is undertaken.^{6,8,70} This is likely the result of a shift in inflammation biomarkers, insulin resistance, and sex and metabolic hormone levels that favour cancer risk reduction in response to moderate and vigorous leisure activities but not to light intensity household activities.^{12,71} Therefore, leisure PA is a logical target for population health interventions aimed at cancer prevention.

Limitations of the study

Our study had some limitations, including in interpreting the findings. Although fairly typical of random digit dialing (RDD) studies, the response rate was low, at less than 25%, and the unweighted sample was not representative of the Alberta population. Despite trying to weight prevalence estimates to reflect more closely those of the Alberta population, the generalizability of our results may be limited. The data regarding PA were self-reported, which may result in over-reporting of activity levels due to social desirability bias. Measurement error and inaccurate estimates may have also come about because it can be difficult to recall PA;¹⁸ participants in our study were asked to remember exercise patterns from over a year-long period. However, the PYTPAQ has been shown to be valid and reliable in a large random sample of men and women.²⁵ Our use of previously validated and reliability-tested instruments to measure PA and all other variables helped to

minimize potential measurement error.²⁵ In addition, the cross-sectional design of this study limits the interpretation of results to correlations and not as causal associations. Nonetheless, these results have identified factors that warrant further investigation as important intervention targets for increasing PA for cancer prevention in the population.

Recommendations

Given that 42% of Albertans are insufficiently active for general health benefits, future interventions should focus on encouraging sedentary individuals to exercise. These efforts should include the promotion of higher levels of PA to confer additional benefits for cancer prevention among this segment of the population as well as those who are already active. In 2005, Canadians spent approximately 6 hours each day on leisure activities, from watching television and surfing the internet, to participating in numerous hobbies, both sedentary and active.⁷² The availability of so many options for leisure time activities poses a challenge for physical activity promotion. It also highlights the need for effective interventions that strengthen those factors that facilitate physical activity and reduce any barriers to them.

Current national guidelines may not be sufficient for cancer prevention, nor for weight management.⁷³ Given the ample evidence that obesity contributes to cancer risk, promoting sufficient levels of PA to support weight loss and management may be an important target for cancer prevention strategies in the population. Moreover, the specific dose of necessary PA is not clear, hence the variations in the guidelines. Guideline development depends on the evolving research linking PA to cancer,^{19,21} which has consisted mainly of observational studies of varying designs.⁷³ Randomized trials are needed to make definitive dose recommendations, and until these exist, it may be prudent to provide a graded set of guidelines that highlight the health benefits associated with various levels and intensities of PA, including those levels that will lead to a greater cancer

risk reduction.⁷⁴ Lastly, further research is needed to develop effective interventions to promote PA that include individual-level motivational factors as well as social and environmental facilitators of PA.

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References

1. Canadian Cancer Society's Steering Committee. Canadian Cancer Statistics 2011: featuring colorectal: featuring colorectal cancer. Toronto (ON): Canadian Cancer Society; 2011.
2. National Cancer Institute of Canada. Canadian Cancer Statistics 2004. Toronto (ON): National Cancer Institute of Canada; 2004.
3. Colditz GA, Sellers TA, Trapid E. Epidemiology - identifying the causes and preventability of cancer? *Nat Rev Cancer*. 2006;6(1):75-83.
4. Stein CJ, Colditz GA. Modifiable risk factors for cancer. *Brit J Cancer*. 2004;90(2):299-303.
5. Courneya KS, Friedenreich CM, editors. Physical activity and cancer. Berlin (DE): Springer; 2011.
6. Wolin KY, Yan Y, Colditz GA, Lee IM. Physical activity and colon cancer prevention: a meta-analysis. *Br J Cancer*. 2009;100(4):611-6.

7. Cust AE. Physical activity and gynecologic cancer prevention. In: Courneya KS, Friedenreich CM, editors. *Physical activity and cancer*. New York (NY): Springer; 2011. p. 159-88.
8. Monninkhof EM, Elias SG, Vlems FA, van der Tweel I, Schuit AJ, Voskuil DW, et al. Physical activity and breast cancer: a systematic review. *Epidemiology*. 2007;18(1):137-57.
9. Leitzmann ME. Physical activity and genitourinary cancer prevention. In: Courneya KS, Friedenreich CM, editors. *Physical activity and cancer*. New York (NY): Springer; 2011. p. 43-72.
10. Rogers CJ, Colbert LH, Greiner JW, Perkins SN, Hursting SD. Physical activity and cancer prevention: pathways and targets for intervention. *Sports Med*. 2008;38(4):271-96.
11. Neilson HK, Friedenreich CM, Brockton NT, Millikan RC. Physical activity and postmenopausal breast cancer: proposed biologic mechanisms and areas for future research. *Cancer Epidemiol Biomarkers Prev*. 2009;18(1):11-27.
12. McTiernan A. Mechanisms linking physical activity with cancer. *Nat Rev Cancer*. 2008;8(3):205-11.
13. Renehan AG, Soceromatarum I, Leitzmann ME. Interpreting the epidemiological evidence linking obesity and cancer: a framework for population attributable risk estimations in Europe. *Eur J Cancer*. 2010;46(14):2581-92.
14. Wolin KY, Carson K, Colditz GA. Obesity and cancer. *Oncologist*. 2010;15(6):556-65.
15. Sharratt MT, Hearst WE. Canada's physical activity guides: background, process, and development. *Can J Public Health*. 2007;98(2):S9-15.
16. Canadian Society for Exercise Physiology. Canadian physical activity guidelines for adults 18-64 years [Internet]. Ottawa (ON): CSEP; 2003 [cited 2003 Oct 14]. Available from: [http://www.csep.ca/CMFiles/Guidelines/CSEP InfoSheets adults ENG.pdf](http://www.csep.ca/CMFiles/Guidelines/CSEP%20InfoSheets%20adults%20ENG.pdf)
17. Sallis JF, Owen N. Physical activity and behavioral medicine. Thousand Oaks (CA): SAGE Publications, Inc.; 1999. Chapter 5, Measuring physical activity; p. 71-91.
18. Pettee KK, Storti KL, Ainsworth BE, Kriska AM. Measurement of physical activity and inactivity in epidemiological studies. In: Lee IM, editor. *Epidemiologic methods in physical activity studies*. New York (NY): Oxford University Press; 2009. p. 15-33.
19. Byers T, Nestle M, McTiernan A, Doyle C, Currie-Williams A, Gansler T, et al. American Cancer Society guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin*. 2002;52(2):92-119.
20. U.S. Department of Health and Human Services and U.S. Department of Agriculture. Dietary guidelines for Americans, 2005. Washington (DC): U.S. Department of Health and Human Services; 2005. Joint publication of the U.S. Department of Agriculture; 2005.
21. World Cancer Research Fund and the American Institute for Cancer Research. Food, nutrition, physical activity and the prevention of cancer: a global perspective. Washington (DC): American Institute for Cancer Research; 2007.
22. Bryant H, Robson PJ, Ullman R, Friedenreich C, Dawe U. Population based cohort development in Alberta, Canada: a feasibility study. *Chronic Dis Can*. 2006;27(2):51-9.
23. Lavrakas PJ. Telephone survey methods sampling, selection, and supervision. 2nd ed. Thousand Oaks (CA): SAGE Publications; 1993. Chapter 2, Random Digit Dialing; p. 33-48.
24. Statistics Canada. Residential Telephone Service Survey (RTSS). Ottawa (ON): Statistics Canada; 2001.
25. Friedenreich CM, Courneya KS, Neilson HK, Matthews CE, Willis G, Irwin M, et al. Reliability and validity of the Past Year Total Physical Activity Questionnaire. *Am J Epidemiol*. 2006;163:959-70.
26. Statistics Canada. Canadian Community Health Survey (CCHS): Cycle 1.1: extending the wealth of health data in Canada. Available from: http://www.statcan.ca/english/concepts/health_sante/cchs_esc_info.htm
27. National Cancer Institute. A 16-year randomized screening study for prostate, lung, colorectal and ovarian cancer - PLCO Trial [Internet]. Bethesda (MD): National Cancer Institute; 1993 [cited 2010 Mar 4]. Available from: <http://www.cancer.gov/clinicaltrials/PLCO1>
28. International Agency for Research on Cancer. EPIC Project [Internet]. Lyon (FR): World Health Organization; 2010 [cited 2010 Mar 4]. Available from: <http://epic.iarc.fr/about.php>
29. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc*. 2000;32(9 Suppl):S498-S504.
30. Sherbourne CD, Stewart AL. The MOS social support survey. *Soc Sci Med*. 1991;32(6):705-14.
31. Statistics Canada. 2001 Census of Canada. Ottawa (ON): Statistics Canada; 2003 [cited 2010 Mar 4]. Available from: <http://www12.statcan.ca/english/census01/home/index.cfm>
32. Statistics Canada. Canadian Community Health Survey 2003: User Guide for the Public Use Microdata File. Ottawa (ON): Statistics Canada; 2005 [cited 2010 Mar 4]. Available from: http://www.statcan.gc.ca/dli-ild/meta/cchs_esc/cycle2_1/guide_eng.pdf
33. Norman GR, Streiner DL. Biostatistics: the bare essentials. 2nd ed. Hamilton (ON): BC Decker; 2000. Chapter 14, Multiple regression; p. 127-38.
34. Kleinbaum DG, Klein M. Logistic regression: a self-learning text. 2nd ed. New York (NY): Springer; 2002. Chapter 6, Modeling strategy guidelines; p. 161-90.
35. Harrell FE. Regression modeling strategies. New York (NY): Springer; 2001. Chapter 5, Resampling, validating, describing, and simplifying the model; p. 87-104.
36. Harrell FE. Regression modeling strategies. New York (NY): Springer; 2001. Chapter 10, Binary logistic regression; p. 215-68.
37. StataCorp LP. STATA Release 10.0. College Station (TX): Stata Corporation; 2001.

38. Janz NK, Champion VL, Strecher VJ. The health belief model. In: Glanz K, Rimer BK, Lewis FM, editors. *Health behavior and health education: Theory, research and practice*. 3rd ed. San Francisco (CA): Jossey Bass; 2001. p. 45-66.
39. Loitz C, Berry TR, Spence JC. 2009 Alberta survey on physical activity: a concise report. Edmonton (AB): Alberta Centre for Active Living; 2009.
40. Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults' participation in physical activity: review and update. *Med Sci Sports Exerc*. 2002;34(12):1996-2001.
41. Seefeldt V, Malina RM, Clark MA. Factors affecting levels of physical activity in adults. *Sports Med*. 2002;32(3):143-68.
42. Ross CE. Walking, exercising, and smoking: Does neighborhood matter? *Soc Sci Med*. 2000;51(2):265-74.
43. Azevedo MR, Araujo C, Reichert FF, Siqueira FV, da Silva MC, Hallal PC. Gender differences in leisure time physical activity. *Int J Public Health*. 2007;52(1):8-15.
44. Barrett JE, Plotnikoff RC, Courneya KS, Raine KD. Physical activity and type 2 diabetes: exploring the role of gender and income. *Diabetes Educ*. 2007;33(1):128-43.
45. Parsons EM, Betz NE. The relationship of participation in sports and physical activity to body objectification, instrumentality, and locus of control among young women. *Psychol Women Q*. 2001;25(3):209-22.
46. Stutts WC. Physical activity determinants in adults: perceived benefits, barriers, and self efficacy. *AAOHN J*. 2002;50(11):499-507.
47. McDermott L. A qualitative assessment of the significance of body perception to women's physical activity experiences: revisiting discussions of physicalities. *Sociol Sport J*. 2000;17(4):331-63.
48. Thompson AM, Humbert M, Mirwald RL. A longitudinal study of the impact of childhood and adolescent physical activity experiences on adult physical activity perceptions and behaviors. *Qual Health Res*. 2003;13(3):358-77.
49. Levine JA, McCrady SK, Lanningham-Foster LM, Kane PH, Foster RC, Manohar CU. The role of free living daily walking in human weight gain and obesity. *Diabetes*. 2008;57(3):548-54.
50. Dishman RK, Sallis JF. Physical activity, fitness, and health: International proceedings and consensus statement. Bouchard C, Shephard RJ, Stephens T (editors). Champaign (IL): Human Kinetics Publishers; 1994. Chapter 3, Determinants and interventions for physical activity and exercise; p. 214-38.
51. Godin G, Belanger-Gravel A, Nolin B. Mechanism by which BMI influences leisure time physical activity behavior. *Obesity*. 2008;16(6):1314-7.
52. Fox KR, Hillsdon M. Physical activity and obesity. *Obes Rev*. 2007;1:115-21.
53. Lau DC, Douketis JD, Morrison KM, Hramiak IM, Sharma AM, Ur E, et al. 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children. *CMAJ*. 2007;176(8):117.
54. Physical Activity Advisory Committee. Physical Activity Guidelines Advisory Committee report, 2008. Washington (DC): U.S. Department of Health and Human Services; 2008.
55. Bensimhon DR, Kraus WE, Donahue MP. Obesity and physical activity: a review. *Am Heart J*. 2006;151(3):598-603.
56. Mortensen LH, Siegler IC, Barefoot JC, Gronbaek M, Sorensen TIA. Prospective associations between sedentary lifestyle and BMI in midlife. *Obesity*. 2006;14(8):1462-71.
57. Petersen L, Schnohr P, Sorensen TIA. Longitudinal study of the long term relation between physical activity and obesity in adults. *Int J Obes Relat Metab Disord*. 2003;28(1):105-12.
58. Giles Corti B, Donovan RJ. Socioeconomic status differences in recreational physical activity levels and real and perceived access to a supportive physical environment. *Prev Med*. 2002;35(6):601-11.
59. Booth ML, Macaskill P, Owen N, Oldenburg R, Marcus BH, Bauman A. Population prevalence and correlates of stages of change in physical activity. *Health Educ Q*. 1993;20(3):431-40.
60. Statistics Canada. Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2007 boundaries) and peer groups, occasional. Table 105 0501 (All Canada) [Internet]. Ottawa (ON): CANSIM (database); 2007 [cited 2011 Feb 18]. Available from: <http://www5.statcan.gc.ca/cansim/a01?lang=eng>
61. Statistics Canada. Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2007 boundaries) and peer groups, occasional. Table 105 0501 (Alberta) [Internet]. Ottawa (ON): CANSIM (database); 2007 [cited 2009 Mar 18]. Available from: <http://cansim2.statcan.gc.ca/cgi-bin/cnsmcgi.exe?lang=E&CNSM=F1-CH/CH1-eng.htm>
62. Statistics Canada. Canadian Community Health Survey, cycle 2.1 questionnaire. 2003 [cited 2009 January 17]. Available from: http://www.statcan.gc.ca/concepts/health_sante/cycle2_1/quest-eng.htm
63. Pereira MA, FitzerGerald SJ, Gregg EW, Joswiak ML, Ryan WJ, Suminski RR, et al. A collection of Physical Activity Questionnaires for health related research. *Med Sci Sports Exerc*. 1997;29(6 Suppl):S1-205.
64. Centers for Disease Control and Prevention. Adult participation in recommended levels of physical activity United States, 2001 and 2003. *MMWR*. 2005;54(47):1208-12.
65. Sjostrom M, Oja P, Hagstromer M, Smith BJ, Bauman A. Health enhancing physical activity across European Union countries: the Eurobarometer study. *J Public Health*. 2006;14(5):291-300.
66. Colley RC, Garrigue D, Janssen I, Craig CL, Clarke J, Tremblay MS. Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Rep*. 2011;22(1):15-23.

67. Ruttan A, Abu Omar K. Prevalence of physical activity in the European Union. *Soz. Präventivmed.* 2004;49(4):281-9.
68. Ruttan A, Ziemann H, Schena F, Stahl T, Stiggelbout M, Auweele YV, et al. Using different physical activity measurements in eight European countries. Results of the European Physical Activity Surveillance System (EUPASS) time series survey. *Public Health Nutr.* 2003;6(4):371-6.
69. Bauman A, Ainsworth BE, Bull F, Craig CL, Hagströmer M, Sallis JF, et al. Progress and pitfalls in the use of the International Physical Activity Questionnaire (IPAQ) for adult physical activity surveillance. *J Phys Act Health.* 2009;6(1).
70. Friedenreich CM, Cust AE. Physical activity and breast cancer risk: impact of timing, type and dose of activity and population subgroup effects. *Brit J Sports Med.* 2008;42(8):636-47.
71. Autenrieth C, Schneider A, Döring A, Meisinger C, Herder C, Koenig W, et al. Association between different domains of physical activity and markers of inflammation. *Med Sci Sports Exerc.* 2009;41(9):1706-13.
72. Hedi F. Sport participation in Canada, 2005. Ottawa (ON): Statistics Canada; 2008. Available from: http://publications.gc.ca/collections/collection_2008/statcan/81-595-M/81-595-MIE2008060.pdf
73. Friedenreich CM, Neilson HK, Lynch BM. State of the epidemiological evidence on physical activity and cancer prevention. *Eur J Cancer.* 2010;46(14):2593-604.
74. Cerin E, Leslie E, Bauman A, Owen N. Levels of physical activity for colon cancer prevention compared with generic public health recommendations: population prevalence and sociodemographic correlates. *Cancer Epidemiol Biomarkers Prev.* 2005;14(4):1000-2.

National Fall Prevention Workshop: stepping up pan-Canadian coordination

Centre for Health Promotion, Public Health Agency of Canada; British Columbia Injury Research and Prevention Unit (BCIRPU)

Background

About one in three Canadian seniors will experience a fall at least once each year.^{1,4} Such falls are the leading cause of injury-related hospitalizations among older people.⁵ Apart from causing injury, falls can result in chronic pain, reduced quality of life and, in severe cases, death. Psychological effects of a fall may cause a post-fall syndrome that includes dependence on others for daily activities, loss of autonomy, confusion, immobilization and depression.¹

Falls and the resulting injuries often occur due to a combination of factors, including health conditions associated with aging such as vision problems, osteoporosis, dementia and symptoms of a chronic disease. They can be due to the side effects of medications, environmental hazards and risk-taking behaviours.

Fall prevention initiatives and strategies are taking place in all provinces and territories and at the national level. To enhance the collaborative understanding of these initiatives, a National Fall Prevention Workshop was held at the Canadian Injury Prevention and Safety Promotion Conference in Vancouver, British Columbia, on 17 November 2011. The Workshop was co-hosted by the British Columbia Injury Research and Prevention Unit (BCIRPU) and the Public Health Agency of Canada (PHAC). Fall prevention leads from each province and territory were invited to present their most recent activities and their plans. This event proved to be highly successful with over 60 attendees representing all the provinces and Yukon (see Table 1).

TABLE 1
Workshop attendees and presenters

Jurisdiction	Agency represented
Canada	Division of Aging and Seniors, Public Health Agency of Canada
British Columbia	BC Ministry of Health BC Injury Research and Prevention Unit
Alberta	Health Professions Strategy & Practice, Alberta Health Services Alberta Centre for Injury Control & Research Fall Risk Management Program, Alberta Health Services - Calgary Zone
Saskatchewan	Acquired Brain Injury Partnership Project, Ministry of Health
Manitoba	Department of Manitoba Healthy Living, Youth and Seniors, Healthy Living and Populations Branch
Ontario	Ontario Injury Prevention Resource Centre SMARTRISK
Quebec	Institut national de santé publique du Québec
New Brunswick	Office of the Chief Medical Officer of Health, New Brunswick Department of Health
Prince Edward Island	Spectrum Solutions
Nova Scotia	Nova Scotia Department of Health and Wellness
Newfoundland and Labrador	Chronic Disease Control Division, Department of Health and Community Services
Yukon	Arctic Institute of Community Based Research

Workshop objectives

The objectives of the 2011 National Fall Prevention Workshop were to

- 1) bring together federal, provincial and territorial leads interested in collaborating on evidence-based, clinically relevant programming, policy and practice to reduce the risk of falls and related injuries among older adults in Canada;
- 2) present model strategic fall prevention plan components from each province/territory;
- 3) discuss current best practices and their application in each province and territory, including data standardization

for fall-related morbidity, fall risk assessment tools and protocols, implementation of best practices and evaluation of progress and outcomes.

Summary of workshop discussions

Education and training

Education of health care providers was identified as a priority, with the Canadian Fall Prevention Curriculum (CFPC) cited by most participants as the training program of choice. Standardizing and integrating fall prevention training into postsecondary education was considered an important next step.

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Accreditation

Accreditation Canada's *Required Organizational Practices* for fall prevention was frequently cited as the impetus for developing fall prevention strategies in health care settings.⁶

Leadership and strategic planning

Many attendees identified that while work on fall prevention is ongoing in parts of their jurisdictions, there is no consistency across their province or territory. Some participants recommended developing a sustainable, evidence-based fall prevention strategy with feasible solutions to facilitate a coordinated approach; however, it was noted that fiscal considerations were a limiting factor to implementing such initiatives.

Team communication

Networks and coalitions were frequently referred to as an important medium for professionals to communicate about implementing fall prevention programming.

Data and surveillance

Jurisdictions that reported having access to data were able to demonstrate a positive relationship between their fall prevention programs and a reduction in falls and fall-related injuries. Several jurisdictions reported that lack of data and surveillance at the setting and at provincial/territorial level made it difficult to evaluate programs rigorously.

Next steps

The 2011 National Fall Prevention Workshop introduced the idea of a National Fall Prevention Collaborative composed of the provincial and territorial leads who presented at the workshop, with the potential for other interested stakeholders to participate. The presenters all agreed to build on the momentum from the workshop to formally establish a practice network and virtual library of best/promising practices. In the interests of further collaboration—and building on the success of the workshop—participants recommended a larger-scale national conference on fall preventions, which could take place in 2014, to bring together provincial/territorial and federal health care providers and policy makers as well as other interested stakeholders to share knowledge and create networks that further advance fall prevention initiatives.

Acknowledgements

The workshop organizers wish to thank the workshop attendees for their involvement and collaboration. Special thanks are also extended to Joanne Veninga, Lori Wagar and Sarah Elliot for their assistance in organizing the workshop.

References

1. World Health Organization. WHO global report on falls prevention in older age. Geneva (CH): World Health Organization; 2007.
2. Scott VJ, Peck SH, Kendall PR. Prevention of falls and injuries among the elderly: a special report from the Office of the Provincial Health Officer, January 2004. Victoria (BC): Provincial Health Officer, British Columbia Ministry of Health Planning; 2004.
3. Tinetti ME, Speechley M. Prevention of falls among the elderly. *N Engl J Med*. 1989;320(16):1055-9.
4. O'Loughlin JL, Robitaille Y, Boivin JF, Suissa S. Incidence of and risk factors for falls and injurious falls among the community dwelling elderly. *Am J Epidemiol*. 1993;137:342-54.
5. Public Health Agency of Canada. Report on seniors' falls in Canada. Ottawa (ON): Division of Aging and Seniors, Public Health Agency of Canada; 2005.
6. ROPS: Required Organizational Practices - September 2011. Ottawa (ON): Accreditation Canada; 2011 Jul [cited 2012 Feb 2]. Available from: <http://www.accreditation.ca/uploadedFiles/ROP%20Handbook.pdf>

Report summary

Injury in Review, 2012 Edition: Spotlight on Road and Transport Safety

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Abstract

Injury in Review, 2012 Edition: Spotlight on Road and Transport Safety, the first national public health report of its kind, synthesizes road- and transport-related injury statistics from a variety of sources. It profiles injury patterns among Canadians aged up to 24 years, explains risks and protective factors, and makes recommendations for action. The findings inform the development of targeted injury prevention efforts.

Introduction

Injuries^{*} are the leading cause of death among Canadians aged 1 to 44 years and the fourth leading cause of death among Canadians of all ages. Many non-fatal injuries result in impairments and disabilities such as blindness, spinal cord injury and intellectual deficit due to brain injury. Between 1979 and 2007 (the year of the most recent available data for all provinces and territories at time of publication), the number of road fatalities in Canada decreased by 73%; however, motor vehicle traffic collisions remain the leading cause of injury death among Canadians aged 1 to 24 years.

The current report presents national surveillance statistics on injury and mortality in Canada from the leading causes, including road- and transport-related causes, among children, youth and young adults aged up to 24 years.[†] It also contains important information and tips for young people, parents, caregivers and others interested in helping to prevent road- and transport-related injuries.

Select Results

Mortality

Injury was the leading cause of death among Canadians aged 1 to 44 years and the fourth leading cause of death among all Canadians of all ages in 2007. Suffocation was the leading cause of injury-related mortality among infants (< 1 year), while motor vehicle traffic (MVT) collisions led among those aged 1 to 24 years, suicide among those aged 25 to 69 years, and falls among those aged 70 years or older.

In 2007, of every 100 000 Canadians aged under 25 years, 19 were fatally injured, 7 as a result of unintentional MVT-related collisions. MVT-related deaths

have declined sharply since the early 1970s; most notably, the mortality rate for those aged 15 to 24 years declined from 46.4 per 100 000 population in the early 1970s to 15.0 per 100 000 population in 2007. It is important to note that this dramatic decline started within two years of the introduction of mandatory seat belts in all new cars in 1971.

In 2007, 20- to 24-year-old men were 3 times more likely to die in MVT collisions than were women in the same age group.

Hospitalization

In 2008/2009,[‡] injury was the leading cause of hospitalization among Canadians aged 10 to 24 years and the third leading cause of hospitalization among Canadians of all ages. Falls were the leading cause of injury-related hospitalization overall; however, among 15- to 19-year-old youth, intentional self-harm was the leading cause of hospitalization. Of every 100 000 Canadians aged under 25 years, 418 were hospitalized due to injuries in general and 46 due to unintentional MVT collisions. In the same period, 20- to 24-year-old men were almost twice as likely to be hospitalized for injury compared with women (odds ratio [OR] = 1.8).

* All causes of injury (intentional and unintentional) excluding adverse effects due to medical or surgical care.

† Alcohol-related mortality statistics also refer to older age groups.

‡ Hospitalization data are traditionally reported according to a fiscal year beginning April 1 and ending on March 31 the following year. Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) statistics are also presented by fiscal year to allow for timely reporting on the most recent data available and for comparability with hospitalization statistics.

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Off-highway vehicle-related injuries

Data for 2008/2009 from the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP)⁸ show that the proportion of young Canadians (0-24 years of age) admitted to hospital for off-highway vehicle (OHV)-related injuries was almost twice that of those admitted for MVT-related injuries, at 24.8% versus 13.8%, respectively. The number of injuries reported by CHIRPP increased almost 3-fold for all-terrain vehicles (ATVs) from 1990/91 to 2008/09.

Of the OHV-related cases involving children aged 11 to 15 years, the proportion of these underage drivers injured while in the driver's seat was 60% for ATV-related injuries, 48% for snowmobiles, and 92% for dirt bikes, proportions similar to those observed for 0- to 24-year-olds. For young adults aged 20 to 24 years, the number of ATV-related injuries was more than twice that of dirt bike-related injuries; almost half of all injuries associated with OHV-related collisions among those under 25 years old were fractures.

Vulnerable road users

Vulnerable road users (VRUs) are defined as roadway users who are unprotected by any vehicle structure, for example, cyclists. In the event of a crash, VRUs are susceptible to injury or death due to mass differential. VRUs can be classified as powered or non-powered. *Injury in Review, 2012 Edition* presents annual proportions of non-powered and powered VRU cases reported to CHIRPP, including, for example, pedestrians, pedal cyclists, motorcyclists, and moped and scooter riders.

Restraint use for motor-vehicle occupants

Based on data from Transport Canada's National Collision Database, between 1998 and 2008, unrestrained occupants of

light-duty vehicles (passenger cars, light trucks, vans and sport-utility vehicles [SUVs]) involved in collisions were 3 times more likely to be injured (OR = 3.4) and 16 times more likely to die as a result of injuries (OR = 15.7) sustained in collisions compared with the occupants who used restraints.

Alcohol-related mortality

Based on data from the Traffic Injury Research Foundation's Fatality Database,⁹ 38% of motor vehicle-related fatalities in Canada in 2009 involved alcohol use, with males approximately twice as likely to die in alcohol-related collisions compared with females (OR = 2.3). From 1998 to 2009, there was no significant decrease in the annual proportion of motor vehicle-related fatalities involving alcohol use,¹⁰ demonstrating the need for further prevention efforts.

Economic burden

Injury impacts the families of those who are injured and society as a whole. From a health-oriented perspective, the economic burden of unintentional and intentional injuries in Canada, for all causes and ages combined, was estimated to be \$19.8 billion in 2004 (including both direct and indirect costs), 19% of which related to transport incidents alone.¹

Next steps

Surveillance statistics show an important decline in the rates of motor vehicle traffic-related injuries over the past three decades. Nevertheless, injuries, and in particular transport-related incidents, are a major public health challenge in Canada, and further injury prevention efforts are necessary. The Public Health Agency of Canada (PHAC) continues to collaborate with Health Canada, Safe Kids

Canada, the Traffic Injury Research Foundation and other partners to research and advance knowledge and road safety policies and programs. Together we are contributing to making Canada a safer place for road users.

Ordering instructions for *Injury in Review, 2012 Edition: Spotlight on Road and Transport Safety* are available at <http://www.phac-aspc.gc.ca/injury-bles/chirpp/injrep-rapbles/index-eng.php>.

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References

1. SMARTRISK. The Economic Burden of Injury in Canada. Toronto (ON): SMARTRISK; 2009.

⁸ The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) is an injury surveillance system that collects and analyzes data on injuries, mainly to children, seen at the emergency rooms of the 11 paediatric hospitals and 4 general hospitals in Canada. CHIRPP is a unique, richly detailed database of injury information.

⁹ The Fatality Database is developed and managed by the Traffic Injury Research Foundation. The following agencies have provided funding for the Fatality Database: Health Canada (1973-1982); Transport Canada and the Canadian Council of Motor Transport Administrators (1984-2010; their funding for the Database has been in support of the Strategy to Reduce Impaired Driving for several years).

¹⁰ Fatalities are considered to be alcohol-involved if the fatally injured person was a driver or pedestrian who had been drinking or if at least one driver involved in the collision had been drinking; passenger fatalities are also considered to be alcohol-involved if one of the drivers involved had been drinking. The percentage of alcohol-involved fatalities is calculated from the number of deceased persons categorized as an alcohol-involved fatality, divided by the total number of cases where alcohol involvement in the collision was known.

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